Practical Geometry

Applied to the USEFUL ARTS of

Building, Surveying, Gardening and Menſuration;

Calculated for the SERVICE of

GENTLEMEN as well as ARTISANS,

And ſet to View

In FOUR PARTS.

CONTAINING,

I. PRELIMINARIES or the Foundations of the ſeveral ARTS above-mentioned.

II. The various Orders of Architecture, laid down and improved from the beſt Maſters; with the Ways of making Draughts of Buildings, Gardens, Groves, Fountains, *&c.* the laying down of Maps, Cities, Lordſhips, Farms, *&c.*

III. The Doctrine and Rules of Menſuration of all Kinds, illuſtrated by ſelect Examples in Building, Gardening, Timber, *&c.*

IV. Exact Tables of Menſuration, ſhewing, by inſpection, the ſuperficial and ſolid Contents of all Kinds of Bodies, without the Fatigue of Arithmetical Computation:

To which is annexed,

An Account of the Clandeſtine Practice now generally obtaining in Menſuration, and particularly the Damage ſuſtained in ſelling Timber by Meaſure.

The WHOLE

Exemplifi'd with above 60 Folio Copper Plates, by the beſt Hands.

By *BATTY LANGLEY.*

LONDON:

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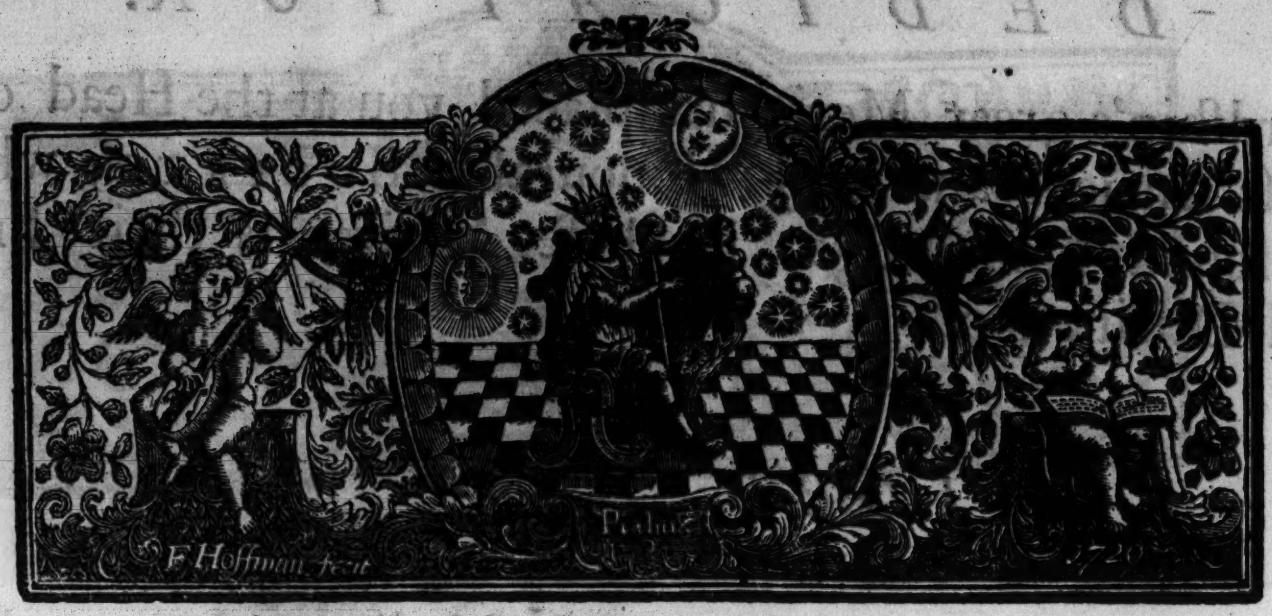
MVSEVM
BRITAN
NICVM



TO THE

Lord PAISLEY.

My LORD,

ALL who are acquainted with the Subjects of the following Treatiſe will acknowledge my Judgment in the Choice I have made of your Lordſhip's Name, which can not fail to recommend it to the peruſal of the Public; And though an Author is very unwilling to beleive his Works deſtitute of real Merit and Uſefulneſs, yet if this Book ſhall meet with Approbation, I am ſenſible how much will be owing to your Lordſhip's Patronage, whoſe known Skill in theſe Sciences is the Foundation of this Trouble.

Permit me to add, that I have a particular Pleaſure in doing myſelf this Honour at a Time when your

DEDICATION.

Lordſhip's great Merit has placed you at the Head of a moſt Ancient and moſt Honourable SOCIETY, whoſe profound Knowledge, in theſe Affairs, is their Pride and Diſtinction. I am,

My LORD,

Your Lordſhip's moſt Obedient,

Moſt Humble,

And moſt Devoted Servant,

B. Langley.

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PREFACE.

THE ſubjects of the preſent treatiſe, on account of their antiquity, uſefulneſs and entertaining variety, having been the delight of the greateſt maſters in knowledge, thro' various ages, are, it muſt be acknowledged, tranſmitted to us in a ſuitable degree of perfection. They have indeed been largely treated of by various hands, but generally in a theoretical, rather than in a practical manner, ſo as to appear ſomewhat intricate and obſcure to ſuch as were not acquainted with the principles of mathematics, or have not applied themſelves in earneſt thereto. My deſign therefore is to treat of architecture, gardening, menſuration and Land-ſurveying, in a method as eaſy and intelligible as it is new and generally uſeful. I ſhall begin with the fundamental, or firſt principles of theſe ſeveral arts, and gradually conduct my reader from the eaſier parts of 'em up to the hardeſt, taking particular care all along to let him ſee the *utile* as well as the *dulce* thereof; the fruitful practice, and not the barren theory only. From a failure of authors in this point, I apprehend it is that theſe arts are at preſent much leſs cultivated than they merit. An author cannot do them greater juſtice, than to paint them as they are, moſt uſeful and delightful employments; of great importance in human life. To convince the world of this truth, as it is the deſign, ſo it wou'd be the higheſt recommendation of the preſent treatiſe. And this I can ſincerely ſay, that I have had a view thereto thro' the execution of the whole deſign. I ſhall not therefore offer at any recommendation of the arts themſelves, which want no able hand to ſet them off with colours, and the winning charms of rhetorick; but leave my reader, from the plain, naked, artleſs facts and obſervations he will meet with in the work, to determine of their merit. And I am greatly miſtaken if to all true judges this does not appear a more equitable, and more unexceptionable procedure than to write, as the uſual manner is, an encomium of the arts I treat of, in order to recommend the work. For if the book cannot be ſupported by its own merit, I am ſure a panegyrick upon its ſubject will but render it the more ridiculous and contemptible. All that I requeſt is a fair and candid peruſal. I deſire only that my reader wou'd come with a mind prepared not to be ſtartled, or prejudiced againſt the author, by the appearance of novelty back'd with reaſon; tho' it at firſt ſight ſhou'd ſeem to thwart ſome current and prevailing opinions. This were a temper that wou'd for ever exclude the light, and droniſhly remain

main content with whatever doctrine happens to have its run. But we of late have ſeen ſuch ſucceſsful inrodes made into opinions once thought juſt, that we cannot be too ſuſpicious of our entertaining eſtabliſh'd errors for truth, and ſhutting our eyes againſt plain fact and obvious reaſon. 'Tis not that I pretend to a faculty beyond that of others in diſcovering the truth in the particulnr ſubjects I have here treated; but my genius leading me to ſuch kind of ſtudies, I hope I may be allowed to have obſerved the common things, and to make my own uſe of them. If what I alledge be true, (for which I always give my reaſons) the world will have the advantage; but if it ſhall prove to be falſe, I ſhall willingly bear the blame: Only I make this requeſt, that I may be cenſured by the proper judges, and ſuch as have been converſant in the ſame kind of ſtudies with my ſelf; otherwiſe the world, I hope, will agree with me, that I am condemn'd unjuſtly. That the reader may form the better judgment of the performance, he may be pleaſed to take the following account thereof.

Geometry being the baſis of architecture, gardening, menſuration and land-ſurveying, (which are the ſubjects of this treatiſe) I have in the firſt part, laid down all the moſt uſeful and neceſſary geometrical definitions, problems, theorems, and axioms, that are abſolutely neceſſary to be well underſtood by every one who deſires to be a complete artiſan, and thoſe in a moſt conciſe and familiar manner. The ſecond part contains the application of the firſt to practiſe in the geometrical conſtruction of all kind of ſcales for the delineating, and menſuration of all ſorts of plans and uprights, and of the *Tuſcan*, *Dorick*, *Ionick*, *Corinthian*, *Compoſite*, *French* and *Spaniſh* Orders of architecture, with their derivation, proportion, *&c.* in general. And ſeeing that neither ancient or modern architects have yet agreed on the meaſures of the principal parts of entire columns: I ſhall therefore before I proceed any further, demonſtrate the ſame particularly.

The principal parts of entire columns are three, *viz.* The pedeſtal, the column, and the entablature; all which are ſeverally divided into three other parts. As firſt, the pedeſtal by its baſe, die, and cornice; the column by its baſe, ſhaft and capital, and the entablature by its architrave. Freeze and corniſh, whoſe ſeveral heights and projectures are meaſured by modules and minutes. (*Vide* prob. the 9th ſect. 1. part 2d.)

(1.) Pedeſtals, (called by the ancients *Stylobatæ*) are of two kinds, *viz.* The one broken, and the other continued. Broken pedeſtals, are parts of a continued pedeſtal, which project or break out, right under each column, as in the Theatre of *Marcellus*, the arches of *Titus*, *Septimius*, and *Conſtantine* in the *Coliſeum*, and in the altars of the *Pantheon*. Continued pedeſtals are ſuch as range throughout, without projectures or breaks under each column, as in the Goldſmith's arch, the temple of *Veſta* at *Tivoli*, and that of *Fortuna Virilis*.

Both ancient and modern architects have delivered rules for the heights of entire pedeſtals, but all different, whereby the young architect is at a loſs to know, among the ſeveral, which is the beſt.

Palladio makes the height of the *Tuſcan* pedeſtal three modules; the *Dorick* four modules and five minutes; the *Ionick* five modules four minutes; the *Corinthian* five modules one minute, and the *Compoſite* ſix modules ſeven minutes.

Scammozzi makes the height of the *Tuſcan* pedeſtal three modules twelve minutes; the *Dorick* four modules eight minutes; the *Ionick* five modules; the *Corinthian* ſix modules eleven minutes, and the *Compoſite* ſix modules two minutes.

Vignola

Vignola makes the height of the *Tuſcan* pedeſtal five modules; the *Dorick* five modules four minutes; the *Ionick* ſix modules, and the *Corinthian* and *Compoſite* ſeven modules each.

Serlio makes the height of the *Tuſcan* pedeſtal four modules fifteen minutes; the *Dorick* ſix modules; the *Ionick* ſix modules; the *Corinthian* ſix modules fifteen minutes, and the *Compoſite* ſeven modules four minutes. The height of the *Ionick* pedeſtals at the temple of *Fortuna Virilis*, is ſeven modules twelve minutes; thoſe of the theatre of *Marcellus* three modules eight minutes, and at the *Coliſeum* four modules twenty two minutes.

The height of the *Corinthian* pedeſtals, at the altars of the *Pantheon*, are ſeven modules twenty eight minutes; the *Coliſeum* four modules two minutes, and the *Compoſite* pedeſtals of the Goldſmiths-arch, ſeven modules eight minutes.

Now ſince 'tis abſolutely neceſſary, that theſe diverſities ſhould be reduced to a mean proportion, for a ſtandard meaſure, therefore I have done it, and is as following, *viz.* Make the entire height of the *Tuſcan* pedeſtal equal to two diameters or modules. The *Dorick* to two modules twenty minutes; the *Ionick* to two modules forty minutes; the *Corinthian* to three modules, and the *Compoſite* to three modules twenty minutes, the progreſſion being of forty minutes.

N. B. That a module is a length equal to the diameter of the baſe of the column, divided into ſixty equal parts called minutes.

The difference in the proportions of the parts of pedeſtals, are as great as thoſe of their heights, and therefore I have alſo eſtabliſhed this one general proportion for the parts of all pedeſtals, *viz.* Divide the height of any pedeſtal (be it *Tuſcan*, *Dorick*, *Ionick*, *Corinthian* or *Compoſite*) into one hundred and twenty equal parts, and of thoſe parts give to the ſocle twenty, to the mouldings of the baſe ten; to the die or trunk ſeventy five, and to the cornice fifteen.

The proportions aſſigned for the projecture of the baſe and corniſh of pedeſtals, by both ancient and modern architects, are as various as their other parts, and therefore in this point alſo, I have reduced the diverſities to a mean proportion, that thereby a general rule may be obſerved throughout the five orders, *viz.* In any order, be it *Tuſcan*, *Dorick*, *Ionick*, *Corinthian*, or *Compoſite*, make the baſes of pedeſtals, (excluſive of their zocolo or plinth) with a projecture equal to their altitude, which being different in every order, will therefore cauſe the projecture of the baſe to be different in each order. In the projecture of cornices of pedeſtals, made by either ancients or moderns, there is but little difference, for they uſually make their projecture equal to (or very little more, than) that of the baſe, of which the laſt is to be preferr'd; and therefore, for a ſtandard rule, I give the following proportions, for the projecture of both baſe and cornice, as follows, *viz.* To the *Dorick* pedeſtal, I give to the projecture of the baſe twelve minutes, and to the cornice fourteen. To the *Ionick* pedeſtal I give to the projecture of the baſe fourteen minutes, and to the cornice ſeventeen. To the *Corinthian* pedeſtal, I give to the projecture of the baſe fifteen minutes, and to the cornice nineteen. And laſtly, to the *Compoſite* pedeſtal, I give to the projecture of the baſe ſixteen minutes, and to the cornice twenty two.

I ſhall now mention another particular belonging to pedeſtals, as is common in all the orders, (and then proceed to the proportions belonging to columns) which is as follows: That the breadth of the die of every pedeſtal be always equal to the projecture of the baſe of its column.

The

The projecture of the baſes of columns, is alſo an unſettled part of architecture. For to the *Tuſcan* baſe *Palladio* and *Scammozzi* allow each forty minutes, as alſo hath the *Trajan*'s column, but *Vignola* allows forty one, and *Serlio* forty two minutes. To the projecture of the *Dorick* baſe, *Palladio* allows forty minutes, *Scammozzi* forty two, *Vignola* forty one, *Serlio* forty four, and at the *Coliſeum* forty minutes.

To the projecture of the *Ionick* baſe, *Palladio*, *Scammozzi*, and *Serlio* allow forty one minutes; *Vignola* forty two; the temple of *Manly Fortune* forty three; and the *Coliſeum* forty minutes. To the projecture of the *Corinthian* baſe, *Scammozzi*, *Serlio*, and the *Coliſeum* allow forty minutes; the portico of the *Pantheon* forty one; the three columns of *Campo Vaccino*, the baths of *Dioeleſian*, *Palladio*, and *Vignola* allow each forty two, and the pilaſters of the portico of the *Pantheon* forty three.

And laſtly, to the projecture of the *Compoſite* baſe, the temple of *Bacchus*, the arch of *Septimius*, *Scammozzi*, and *Serlio*, allow each forty one minutes, *Palladio* and *Vignola* forty two; the baths of *Diocleſian* forty three, and the arch of *Titus* forty four minutes. Hence it appears, that forty two minutes is a mean proportion, between the extremes, and is what I recommend for the projecture of the baſes of columns in general.

The great diverſity of the lengths of columns of the ſame order aſſign'd by architects, is a very difficult point to account for: To the length of the *Tuſcan* column *Vitruvius Palladio*, and *Vignola*, give ſeven diameters or modules. *Scammozzi* ſeven and an half. The *Trajans* column eight, and *Serlio* but ſix diameters.

To the length of the *Dorick* column, *Vitruvius* in temples, allowed ſeven diameters; but in *Portico*'s of temples ſeven diameters and an half; at the *Coliſeum* they conſiſt of nine diameters and an half; and at the theatre of *Marcellus* ſeven modules and fifty minutes; *Scammozzi* gives eight and an half; and *Vignola* eight diameters only.

To the length of the *Ionick* column, *Vitruvius*, *Palladio*, and *Serlio*, give eight diameters forty minutes, as alſo is the *Coliſeum*, and theatre of *Marcellus* at *Rome*.

To the length of the *Corinthian* column, *Vitruvius* gives nine diameters thirty minutes, and *Serlio* nine diameters only; at the porch of the *Pantheon* they are nine diameters thirty ſix minutes.

The temple of *Pantheon* they are nine diameters, thirty ſix minutes. The temple of *Veſta* nine modules thirty nine minutes. The temple of the *Sibil* eight modules ſixteen minutes. The *Coliſeum* eight modules thirty ſeven minutes.

The temple of *Peace* nine modules thirty two minutes: The arch of *Conſtantine* eight modules thirty ſeven minutes: The three columns of the *Campo Vaccino*, ten modules ſix minutes; the porch of *Septimius* nine modules thirty eight minutes; the temple of *Fauſtina* nine modules thirty minutes, and the *Baſilic* of *Antoninus* ten modules exactly.

To the length of the *Compoſite* columns, *Scammozzi* gives nine modules forty minutes, and the ſame is at the temple of *Bacchus*; the arch of *Septimius* nine modules thirty minutes, and the arch of *Titus* ten modules preciſely.

Now

Now, becauſe 'tis reaſonable, that a proportionable length ſhould be eſtabliſhed for the length of columns in general, I have therefore reduced the extremes of their diverſities to a mean proportion as following, *viz.* Make the height of the *Tuſcan* column equal to ſeven diameters or modules, and twenty minutes; the *Dorick* to eight modules; the *Ionick* to eight modules forty minutes; the *Corinthian* to nine modules twenty minutes, and the *Compoſite* equal to ten modules only. So will their progreſſion be proportionable, conſiſting of forty minutes in each column.

The diminiſhing of columns being firſt aſſign'd for that beautiful appearance, as flows therefrom, is made in three different manners. As firſt, to begin the diminution at the baſe of the column, and continue it to the capital. The ſecond is to make the column thicker towards the middle, than at its baſe, diminiſhing of it towards the baſe and capital, which kind of diminution is called the ſwelling. The third and laſt way is according to the antique manner: Beginning the diminution at one third of the height above the baſe of the column, as is ſhewn in folio 63 hereof, and is the moſt beautiful kind of diminution.

The difference and quantity of diminution in each of the orders, is exhibited in ſect. 2. Part 2. hereof.

There being yet no certain determin'd proportion for the height of the aſtragal and cincture, which terminate the ſhaft of a column. I therefore have alſo reduced thoſe members, to ſuch a proportion, as may be applied throughout the orders in general. As firſt to the cincture, I give three minutes, and to the aſtragal three minutes and one third. In the *Pantheon*, the temples of *Veſta* and *Manly Fortune*, and arch of *Titus*, the cinctures are very near three minutes. And in the temple of *Antoninus* and *Fauſtina* ſomething more, as alſo the temple of *Bacchus*, the arch of *Septimius*, and in the bath of *Dioclefian*, from which I have extracted my mean proportions.

The received proportion for the height of the baſes of each order is, to make them equal to the ſemidiameter of the column at its baſe, the *Tuſcan* excepted, in which the cincture is included, which in other orders is not.

In the five orders of architecture, there are three different heights of Capitals. The *Tuſcan* and *Dorick* capitals are always equal to the height of their baſe. The *Ionick* capital, from the top of the abacus to the point of interſection, where the cathetus and voluta interſect each other, at the bottom of the volute; to the ſemidiameter and an eighteenth part thereof. And laſtly, the *Corinthian* and *Compoſite* capitals to one module and ten minutes.

But, notwithſtanding that theſe meaſures are aſſigned for the height of capials, yet 'tis to be obſerved, that the ancients did not obſerve them ſtrictly. For the capital of *Trajan*'s column (which is of the *Tuſcan* order) is leſs than the ſemidiameter of the column's baſe, by a full third; and in the *Dorick* capital of the theatre of *Marcellus*, its height is almoſt thirty three minutes, and that of the *Coliſeum* near thirty eight minutes: Nay, in the *Corinthian* capital of *Vitruvius* (the father of architects) he makes its height but fifty minutes: And therefore I finding that its height was not ſufficient, have introduced a modern capital in its ſtead. At the temple of the *Sibyl* at *Tivoli*, the height of the *Corinthian* capitals are but forty ſeven minutes. In the frontiſpiece of *Nero* ſixty ſix minutes, and in the temple of *Veſta* at *Rome* almoſt ſixty eight minutes. And laſtly, the height of the *Compoſite* capitals of the arches of *Septimius* and the Goldſmiths, are but fifty eight minutes and an half, and the temple of

Bacchus ſixty ſix. Hence appears the oppoſite diverſities, from which are eſtabliſh'd the mean proportions before delivered.

And altho' the proportions of the aforeſaid capitals are very different from each other, yet there is a far greater difference in the height and projecture of entablatures, which they with their columns ſupport.

To the height of the *Tuſcan* entablature, *Vitruvius* allows one hundred and five minutes, *Palladio* one hundred and four minutes, *Scamozzi* one hundred and twelve, *Vignola* one hundred and five, and *Serlio* ninety minutes.

To the height of the *Dorick* entablature, *Vitruvius* allows one hundred and twenty minutes (equal to two modules) *Palladio* one hundred and thirteen minutes: *Scamozzi* one hundred and twenty ſeven minutes; *Vignola* one hundred and twenty; *Serlio* one hundred and twelve; and the like of all other Maſters, as are ſet forth in the 19, 21, 22, 24, 25, 26, 27, 28, and 29th plates hereof, to which I refer.

Now ſeeing that the beauty of an order doth conſiſt in a proportionable entablature; therefore to prevent the deſtruction thereof, by having entablatures either of ſuch a ſize: that they ſeem utterly inſupportable, as thoſe of *Campo Vaccino*, and the frontiſpiece of *Nero*, or on the contrary, too mean and pitiful as the entablatures of *Bullant* and *Delorme*; I adviſe that the height of all entablatures be always equal to two diameters, or one hundred and twenty minutes, and their projecture of the cornice, equal to the height thereof in the *Tuſcan*, *Ionick*, *Corinthian* and *Compoſite* entablatures, and the *Dorick* entablature alſo, when the cornice is made without mutules, (as in that famous ſtructure the *Coliſeum*). But when the *Dorick* entablature hath mutules introduced, their length requires the entire cornice to have more projecture than height.

Having thus demonſtrated the proportions of the principal parts of columns, I ſhall now proceed to the remaining part of my preface.

The third ſection of part 2. contains many excellent architectonical axioms and analogies, collected from moſt grand maſters.

The fourth ſection of part 2. contains the uſe of an inſpectional plain ſcale, which furniſhes the young ſtudent not only with all kind of ſcales, but readily divides the ſeveral parts of a building inſtantly.

The fifth ſection of part 2. contains trigonometrical definitions, with the conſtruction of chords, ſines, tangents, half tangents, ſecants and verſed ſines, applied to practice in the ſolution of the twelve caſes of plain trigonometry, which is performed geometrically alſo, by the help of a plain ſcale and pair of compaſſes, in a very conciſe and familiar manner.

The ſixth ſection of part 2. contains the geometrical conſtruction of draughts, plans, maps of gardens, farms, *&c.* Wherein is ſhewn how to perform ſuch works, much more expeditious and exact than any author yet extant.

The third part contains all the moſt uſeful geometrical axioms and analogies for the menſuration of any ſuperficial figure or ſolid body.

The fourth ſection of part 3. contains the meaſures, and manner of taking the dimenſions of all kinds of work relating to building, as Carpenters, Glaziers, Joiners, Painters, Plaſterers, Maſons, Bricklayers, Paviors, *&c.*

The

The fourth part contains divers inſpection tables of menſuration, whereby any dimenſion may inſtantly be caſt up, without the aſſiſtance of multiplication, or even ſuch capacities as are not maſters of croſs multiplication, are hereby enabled to meaſure any work with as great accuracy, as the beſt accomptant.

The firſt, ſecond, third, fourth, fifth, ſixth, ſeventh, eighth, ninth, tenth, eleventh, twelfth, fifteenth, ſixteenth and ſeventeenth plates, being thoſe which the ſeveral ſubjects hereof have recourſe to, need not in this place ſay any thing thereof.

The thirteenth and fourteenth plates contain a new ſyſtem of gardening, wherein 'tis ſhewn what great improvements may be made, even in the ſmalleſt of gardens; for by the method there obſerved, a ſmall garden may be made to appear as a very large one; and ſuch as are very large, to become the moſt noble and delightful.

And becauſe no gardener can well underſtand the true manner of laying out a garden, even in any manner as bears any proportion, without well underſtanding the elements of geometry; therefore for his ſake, in the firſt part hereof, I have laid down all as is neceſſary to be known in a moſt conciſe and eaſy manner, and applied to practice in the geometrical conſtruction of all kind of lines and figures, as are requiſite for his purpoſe in the practice of gardening. Perhaps that ſome may expect that I ſhould herein treat of the culture of lands, the management of fruit trees, *&c.* which are parts as doth not relate to the mathematical part of gardening, as in deſigning, drawing, laying out, *&c.* But if God permits, I ſhall ſpeedily communicate a treatiſe thereof, wherein I ſhall diſcover many curious experiments, as will prove both pleaſant and advantagious to all lovers of gardening.

The eighteenth, nineteenth, twentieth, twenty firſt, twenty ſecond, twenty third, twenty fourth, twenty fifth, twenty ſixth, twenty ſeventh, twenty eighth and twenty ninth plates, contain the geometrical profiles and elevations of the five orders of architecture, as laid down by all the grand maſters, both ancient, antique, and modern.

The thirty and thirty firſt plates are deſigns for the entrance into ſhady walks; the firſt into a right lined walk, and the other into a curved, or artinatural walk, and thoſe are delineated according to the truth of perſpective.

The thirty third plate contains two deſigns for the enterances into *Grottos* according to the grand manner.

The thirty fourth plate contains divers capitals of the *Corinthian* and *Compoſite* orders, taken from the works of *Vitruvius*, and *Andrew Boſſe*, with an elegant elevation of a noble ſtructure after *Palladio*.

The thirty fifth, thirty ſixth, thirty ſeventh, and thirty eighth plates contain divers geometrical elevations of doors, neathes, *&c.* of the *Tuſcan*, *Dorick*, *Ionick*, *Corinthian* and *Compoſite* orders, adorned with His moſt Sacred Majeſty King *GEORGE*; their Royal Highneſſes the Prince and Princeſs, whom God preſerve.

The thirty ninth plate contains divers excellent deſigns for chimney-pieces, collected from the beſt of maſters.

And

And the fortieth plate, the geometrical elevation of the portico of St. *Mary* the *Egyptian*, with a *Corinthian* frontiſpiece from the Ancients, and the impoſts of the *Tuſcan*, *Dorick*, *Ionick*, *Corinthian* and *Compoſite* orders.

Having thus, by way of preface, explain'd the ſeveral parts of the work, I now recommend you to the practice, deſiring that you wou'd read and examine it, without critical envy, free from pre-occupation that may obſcure your Judgment, and hinder your acknowledging the truth of what I have here preſented for your improvement.

Therefore be not adviſed by ſuch as condemn a conception when they underſtand it not; and believe it falſe becauſe 'tis new; neither imitate thoſe, who ſeeking only to carp at words, neglect the ſenſe of the ſubject.

B. Langley.

THE

THE PRACTICE OF

Architecture, Gardening, Menſuration, and *Land-Surveying,* Geometrically demonſtrated.

PART I.

Of ſuch Geometrical Elements as are abſolutely neceſſary to be well underſtood by every Perſon who deſires to well underſtand the TRUTH of Lineal ARCHITECTURE, GARDENING, and MENSURATION univerſally.

SECT. I.

Of Geometrical Definitions and Rudiments.

PLATE I.

(1.) A Point in the practice of geometry, is the leaſt ſuperficial appearance as can be made by the point of a pen, pencil, pin, *&c.* as the point A, and is to be divided by the mind, tho' not by the hand, into any number of parts, as is conceived, Fig. I. notwithſtanding that *Euclid,* and many other famous geometricians, has defin'd a point to be neither quantity or part of quantity, and therefore not to

be divided into parts: but how 'tis demonſtrated, neither he or any other has ſet forth.

(2.) A line in the practice of Geometry, is a length, with ſuch a breadth, as is given thereunto by the point of the pen, pencil, *&c.* as deſcribes the ſame, which is quite contrary to all other authors, who define a line to be a length without breadth or thickneſs, but without any ſort of demonſtration whatſoever to prove the ſame.

(3.) Of lines there be divers kinds, as right, circular, elliptical, parabolical, hyperbolical, *&c.*

(4.) A right line is generated by the point of a pen, pencil, *&c.* moving from one point to another, the neareſt
Fig. II. way; therefore a right line is the neareſt diſtance contain'd between two points, as the diſtance between the points A, B. The end or limits of all right lines are points, as the points A B.

(5.) A circular line is generated by the motion of one end of a right line. Suppoſe A C to be a right line, fix'd at C as on a center; then by moving it out of the poſition A C to C B, the point A will deſcribe or generate the arch,
Fig. III. or circular line, A B; and if you move it forward to its former poſition A C, the point A will deſcribe or generate the circumference of a circle.

(6.) An elliptical line, or ellipſis, is generated by an ob-
Fig. IV. lique ſection of a cylinder.

(7.) A parabolical line is generated by a parallel ſection
Fig. V. of a cone. As alſo a hyperbolical curve, the former to the ſide, and the latter to the axis.

(8.) As points terminate lines, ſo do lines ſuperficial figures.

(9.) A ſuperficial figure hath length and breadth only, and is contain'd under one termination or many. So
Fig. VII. A is contain'd under one line or termination, B under two, C under three, D under four, E under five, *&c.*

(10.) A circle is a plain geometrical figure, contain'd under one line, called the periferie or circumference.

(11.) Every circumference of a circle is deſcribed according to the 5th hereof, and the point on which the deſcribent reſts, is the center. So in *Fig.* III. the point C is the center thereof. Therefore, as the center of a circle is
Fig. VII. the exact midſt of the ſame, all right lines drawn from thence to the circumference, are equal one to the other, as in *Fig.* VII. A B is equal to B C, and that to B D, *&c.*

Fig. VIII. (12.) The diameter of a circle is a right line drawn through the center, and ending at the circumference, as the line A B C.

(13.) The radius, or ſemidiameter of a circle, is half the diameter.

(14.) A ſection, ſegment, portion, or part of a circle, is a figure contain'd under one right line, and part of the circumference. So the right line A B divideth the circle into two unequal parts, and are the ſections, ſegments, portions, or part of that circle. Fig. IX.

(15.) A ſemicircle is one half of a whole circle, as the figure A.

(16.) A quadrant is one half of a ſemicircle, as the figure B. Fig. X.

(17.) The radius of a quadrant, is either of the ſtreight ſides, as *n m*, or *m o*, and the circular ſide *n o* is called the limb, which is always divided into degrees and min. as will hereafter be fully ſhewn in its proper place.

(18.) An ellipſis is alſo a plain geometrical figure, contain'd under one line, called the circumference, and is generated according to the 6th hereof; and as the diameters of a circle are equal to each other, ſo likewiſe are the diameters of one ellipſis to another, when both are of the ſame dimenſion, but at no other time. Therefore in ellipſis's there is a great variety contain'd.

(19.) Every ellipſis hath two diameters, the one longer than the other; the longeſt diameter is called the conjugate diameter, and the ſhorteſt the tranſverſe diameter; the point of interſection of both diameters as A, is the center of the ellipſis. Fig. XI.

(20.) A triangle is a geometrical figure contain'd under three ſides, and is either right lined as the triangle A, or circular as C, or mix'd as B. Fig. XII.

(21.) When a geometrical figure conſiſts of four ſides and angles, and all equal as the figure B, ſuch a figure is called a quadrat, or geometrical ſquare; but if of the four ſides, two be longer than the other, each to its correſpondent, and the angles equal as the figure C, 'tis called an oblong, long-ſquare, or parallelogram; alſo when the ſides be all equal, and the angles unequal, as the figure D, ſuch a figure is called a rhombus or diamond form; but if ſuch a figure ſhould have two ſides longer and two ſhorter, each to his oppoſite correſponding, as the figure E, 'tis called a rhomboyades; and when the ſides are all unequal, and the angles the ſame as the figure F, ſuch a figure is called a trapezium. Fig. XIII.

(22.) When any figure contains more than four unequal ſides, and angles, ſuch are in general called irregular figures.

(23.) When

(23.) When a geometrical figure contains five equal ſides and angles, as the figure A, ſuch a figure is called a pentagon; and if ſix as B, a hexagon; if ſeven as C, a heptagon; if eight as D, an octagon; if nine as E, a nonagon; and if ten as F, a decagon. Fig. XIV.

(24.) The diagonal lines of a geometrical ſquare, are two right lines, drawn from one angle to the other, as the lines A B and C D. Fig. XV.

(25.) The diameters of a geometrical ſquare, are two right lines drawn through the interſection of the diagonals, parallel to the ſides of the ſquare, as the lines E F and I K.

(26.) The center of a geometrical ſquare, is a point of interſection of the diagonals, or diameters, or both, it being the ſame as the point L. And what is here ſaid of a geometrical ſquare, the ſame is to be underſtood of an oblong, or parallelogram, rhombus, rhomboyades and trapezium. Fig. XV.

(27.) As lines terminate ſuperficial figures, ſo do ſuperficial figures ſolid bodies.

(28.) A ſolid body hath three dimenſions, *viz.* length, breadth, and (thickneſs or) depth.

(29.) Geometrical ſolid bodies, are the ſphere, ſpheriod, cone, fruſtum of a cone, cylinder, pyramis, fruſtum of a pyramis, priſm, tetraedron, fruſtum of a tetraedron, cube, fruſtum of a cube, parallelepipedon, octaedron, dodecaedron, and icoſaedron.

(30.) A ſphere, globe, or ball, is generated by the revolution of a ſemicircle, about its own diameter. So alſo is a ſpheriod, by the revolution of a ſemi-ellipſis on its longeſt diameter, as figure A and B.

(31.) A cone, is generated by the revolution of a right angled plain triangle about one of its legs, as the figure D. So alſo is a cylinder by the revolution of a parallelogram about one of its ſides, as the figure E. Fig. XVI.

(32.) The fruſtum of a cone, is the remains of a cone, when a part thereof is taken away from the upper part, as F L G, taken away from H L I, leaves the fruſtum F G H I; and what is here ſaid of the fruſtum of a cone, the ſame is to be underſtood in the fruſtum of a pyramis or pyrament.

(33.) A pyramis, or pyrament, is a ſolid, which hath a triangle, ſquare, polygon, &c. for its baſe, and hath as many reclining faces as are ſides contain'd in the baſe, which all terminate in a point like a cone, which point, or termination, is called the vertex, or vertical point of the pyrament

pyrament or cone. See figure K, which is a pyrament, whoſe baſe is a geometrical ſquare.

(32.) A priſm is a ſolid body of five faces, three of which are parallelograms, and two equilateral triangles, as the figure M.

(33.) A tetraedron is a ſolid, containing four faces, each an equilateral triangle, and is one of thoſe five bodies, as are called, the regular, or platonick bodies, as the figure N.

(34.) The fruſtum of a tetraedron is a tetraedron with the angles or vertexes cut off, or a ſmall tetraedron cut from every angle. This body thus cut, is compoſed of eight faces, *viz.* four hexagons, and four equilateral triangles, and is as agreeable a body as any herein contained. See figure O.

(35.) A cube is a ſolid body containing ſix faces, each a geometrical ſquare, as figure P.

(36.) The fruſtum of a cube, is a cube with the angles cut off, or 'tis a cube, that has had a pyramis cut from each angle, this ſolid contains fourteen faces, of which ſix are octagons, and eight equilateral triangles, which being taken together is a very handſome body. See figure Q. There is alſo another body, as is not a great deal different from the preceding, which by workmen is called the canted cube, and is no other than the greateſt pyrament, as can be taken from each angle, (which in the former was not.) This body thus cut, contains the ſame number of faces as the preceding; but inſtead of having ſix octagons and eight ſmall triangles, it hath ſix geometrical ſquares, and eight very large equilateral triangles. See figure U. Fig. XVI.

(37.) A parallepipedon is a ſolid body, containing ſix faces (as the cube) whereof but two are geometrical ſquares, and the other four, parallelograms; but a parallepipedon may have all its faces parallelograms, when its ends are parallelograms, inſtead of geometrical ſquares. See the figures R and S.

(38.) An octaedron is a ſolid body, containing eight faces, each an equilateral triangle.

(39.) A dodecaedron is a ſolid body, containing twelve faces, and each a pentagon.

(40.) An Icoſaedron is a ſolid body, containing twenty faces, and each an equilateral triangle.

(41.) The baſis of a ſphere, or ſpheriod, is but a point.

(42.) The baſis of a cylinder is a right line.

(43.) The baſis of a cone is a circle.

(44.) Beſides the preceeding ſolids there be two others, *viz.* one of twelve faces, and another of thirty, and every one a rhombus or diamond form. And as theſe definitions are full ſufficient for any ſurveyor, I ſhall now proceed to the ſecond ſection.

SECT. II.

Of *Geometrical Problems.*

PROBLEM I.

TO divide the right line A B, *into two equal parts, by the perpendicular* d d.

Open your compaſſes to any diſtance, that is more than half the line A B. Place one foot or point in A, and with the other deſcribe an arch as *e e*, then with the ſame opening on B, deſcribe the arch *c c*, which will interſect the firſt arch *e e*, in *d d*; draw a right line from *d* to *d*, the two interſections, and it ſhall divide the given line A B, into two equal parts, in the point E, and ſhall be perpendicular thereunto.

Fig. XVII. A perpendicular is a right line, erected upon a right line, making the angles equal on each ſide, as E *d*, on either ſide A B.

Uſe.

This problem is of great uſe in the ſetting out of buildings and gardens, as well as in drawing or deſigning the ſame on paper. In the practice of which, a ten foot rod, or a garden line, ſupplies the place of compaſſes, for to deſcribe the arches of interſection.

PROBLEM II.

Upon any point as E, *given in the right line* A B, *to erect the perpendicular* I E.

1. Open your compaſſes to any ſmall diſtance, and placing one foot in the given point E, with the other foot interſect the given line on each ſide, as at *c* and *d*.

2. Open your compaſſes to any greater diſtance, and placing one point in *d*, with the other deſcribe the arch

b b; alſo with the ſame opening on the point *e*, deſcribe the arch *a a*, interſecting the firſt arch *b b*, in the point I. Fig. XVIII.

3. Draw the line I E, and it ſhall be the perpendicular required.

Uſe.

This is alſo a very uſeful problem, as alſo are all the enſuing, both in building and gardening, in dividing of the parts thereof, which are too numerous to be inſerted here, and therefore are omitted till a more convenient time, when I ſhall preſent the world with a particular diſcourſe on that ſubject for the inſtruction of ſuch youth, whoſe natural genius tends either to architecture or gardening.

Problem III.

From the end of the right line A C, *at* C, *to erect the perpendicular* C D.

1. Open your compaſſes to any diſtance, and ſet one foot in C, deſcribe the arch B, *n*, *m*, and upon it ſet the ſame opening from B to *n*, and from *n* to *m*. Fig. XIX.

2. With the ſame diſtance, or opening of your compaſſes, deſcribe the arch *n f*, on the point *m*, and alſo the arch *e m*, on the point *n*, interſecting the arch *n f*, in the point D.

3. Draw the right line C D, and it ſhall be the perpendicular required. This problem may be performed many other ways; but none better or eaſier than the preceding and the following.

Problem IV.

How to erect a perpendicular upon the end of a line, after another manner.

1. With any opening of the compaſſes, deſcribe the arch B *g*, on the point C, and ſet that opening from B to *g*.

2. Deſcribe the arch B D E F, on the point *g*, with the ſame opening as before; and upon this arch ſet up the ſame opening three times, *viz.* from B to D, from D to E, and from E to F. Fig. XX.

3. Draw a right line from F to C, and it ſhall be the perpendicular required.

Problem

Problem V.

To let fall a perpendicular line, from a point to a right line given.

☞ In the performance of this problem, there is two caſes. The firſt, is when the given point is over or near the middle of the line. And the ſecond, when near or over the end of the line.

Caſe I.

Let N O, be the right line given, and from the point P to let fall the perpendicular P Q.

1. Open your compaſſes to any diſtance greater than P Q, and on the point P deſcribe the arch R S, interſecting the given line in the points R and S. Fig. XXI.

2. With any opening on the point R deſcribe the arch *v v*, and with the ſame opening on the point S deſcribe the arch *m m*, interſecting the firſt arch, in the point I.

3. Lay a ruler from I to P, and draw the right line P Q, and it will be the perpendicular required.

Caſe II.

Let T, O, be the right line given, and from the point V to let fall the perpendicular V M.

1. From the given point V, to any part of the given line T O, draw a right line as V N, and by the firſt hereof divide it into two equal parts in the point X. Fig. XXII.

2. On the point X with the diſtance V X or X N, deſcribe the arch or ſemicircle V M N, interſecting the given line in the point M.

3. From the point given, to M the interſected point, draw the right line V M, and it ſhall be the perpendicular required.

Problem VI.

To deſcribe a right line, parallel to a right line at any diſtance aſſigned.

Definition.

Parallel right lines are ſuch, that being infinitely continued would never meet.

Of

Of parallel lines there be principally two kinds, *viz.* right lined parallels and circular parallels, as in the following problems.

In deſcribing of right lined parallels, there are two caſes; the firſt, to draw a right line parallel to a right line at any diſtance given; the other, thro' a point aſſign'd, which point may be over, under, or oblique to the given line.

Caſe I.

Let E F be a right line given, and let it be required to draw another right line parallel thereunto, at the diſtance of G H. Fig. XXIII.

1. Take in your compaſſes the given line G H, and on any part of the given line E F, as at E, deſcribe the arch *i k*, as alſo towards the other end, as at F, with the ſame diſtance, deſcribe the arch *c m*.

2. A line drawn by the convexity of thoſe two arches, ſhall be the parallel required, at the parallel diſtance of G H.

Caſe II.

Let A B be a right line given, and let it be required to draw another right line parallel thereunto; that ſhall paſs thro' the point E.

1. Take with your compaſſes the neareſt diſtance from the given point E, to the given line A B, and with that diſtance, at the end A, deſcribe the arch *n n*. Fig. XXIV.

2. A right line drawn through the given point E, by the convexity of the arch *n n*, ſhall be the parallel defired, at the parallel diſtance of the given point E.

Problem VII.

To make the angle M C B, *equal to the given angle* E A N.

1. Upon the angular point A, with any opening of the compaſſes, deſcribe the arch *o o*, and with the ſame opening ſet one point, or foot of the compaſſes, on the point C, and deſcribe the arch *n n*. Fig. XXV.

2. Take the diſtance *o o*, and ſet it from *n* to *n*.

3. A line being drawn from C to *n*, ſhall make the angle M C B, equal to the angle E A N, as required. This problem is of great uſe in taking the plan of buildings, gardens, &c.

Problem VIII.

To divide an angle, as A B C, *into two equal parts.*

1. Upon the angular point B, with any opening, describe the arch *r r*, intersecting the sides of the angle in the points *r r*.

Fig. XXVI. 2. With any opening, on the points *r r*, describe the arches *m m* and *v v*, intersecting each other in the point L.

3. A right line drawn from L to B, shall divide the angle A B C, into two equal parts as required.

Problem IX.

To divide a right line into any number of equal parts.

Let it be required to divide M N into six equal parts.

1. From the end M or N, draw a right line at pleasure, as A M.

Fig. XXVII. 2. Make the angle N M E equal to M N A, by Prob. VII. or by the second case of Prob. VI. make M E parallel to A N.

3. Open your compasses to any small distance at pleasure, and set off that distance five times from N towards A, and from M towards E, as at the points 1, 2, 3, 4, 5.

4. Draw right lines from 5 to 1, from 4 to 2, from 3 to 3, from 2 to 4, and from 1 to 5; and their intersections will divide the given line M N, into six equal parts, as required.

Problem X.

To find a mean proportion between two right lines given. Let it be required to find a mean proportion, between the given lines N *and* O.

1. Make A D, equal in length to both the lines O and N, and by Problem I. divide it into two equal parts, in the point C.

2. On the point C, describe the semicircle, making the

F. XXVIII. diameter equal to A D.

3. At E (the joining of both lines) erect the perpendicular E I, and continue it till it meet the curve in the point I.

4. The line E I is the mean proportion required.

Problem XI.

To find the center of a circle as ſhall paſs through any three points given, as are not in a right line.

Let the three given points be D B A.

1. Draw a right line from any one of the points, as A, to either of the other points, as to B, and alſo draw another right line from B to D.

2. By problem I. divide thoſe two equal parts by two perpendiculars, as the perpendicular lines H F and C E, which perpendicular lines do always interſect each other, and the point of interſection is the center of a circle as will paſs through the points aſſigned. Fig. XXIX.

Problem XII.

To inſcribe a triangle geometrical ſquare, pentagon, hexagon, heptagon, octagon, nonagon, or decagon, within a circle.

1. Deſcribe the circle A F C G, and draw the diameter A C and F G, interſecting each other at right angles, in the center E.

2. Make A B and A D, equal to the ſemidiameter E C, and draw the right line B D, which is the ſide of an equilateral triangle, as may be inſcribed in that circle.

3. Draw the right line A F, and it ſhall be the ſide of a geometrical ſquare.

4. Upon H, with the diſtance H F, deſcribe the arch F I, and draw the right line F I, which is the ſide of a pentagon as may be inſcribed therein. The diameter A C, or F G, is the ſide of a hexagon, and half B D; as H B, or H D, is the ſide of a heptagon or ſeptagon. Fig. XXX.

5. From E, the center through M, draw the right line E M K, ſo ſhall the diſtance, or right line A K, be the ſide of an octagon.

6. Divide the arch B A D, into three equal parts, each of which is the ſide of a nonagon, as D S.

7. The diſtance E I is the ſide of a decagon. Every ſide in the figure is number'd with its proper number,

as

as the ſide of a pentagon with number 5, a hexagon with the number 6, &c.

This figure, thus made, is a very uſeful inſtrument to inſcribe any poligon in a circle, when required; as for example:

Let it be required to inſcribe a nonagon in the circle A B C D.

Fig. XXXI. 1. On the center E, deſcribe the circle F, G, H, I, equal in diameter to the circle A F C G, fig. XXX.

2. From thence take the diſtance S D, and ſet that diſtance from F to V, from V to Q, from Q to P, &c. to the point F, where you began.

3. Lay a ruler from the center E, to the ſeveral points F V Q P, &c. and 'twill cut the outer circle in the points *x x x*, &c.

4. Draw lines from *x* to *x*, &c. and thoſe lines ſhall form the nonagon required. And what is here ſaid of a nonagon, the ſame rule is to be underſtood of any other figure, as before deſcribed.

Problem XIII.

To make an equilateral triangle, as A, B, O, *whoſe ſides ſhall be equal to any given line, as the right line* N M.

1. Make A B equal to the given line N M, and with the diſtance A B, on the point A, deſcribe the arch *v v*, and with the ſame diſtance on the point B, deſcribe the arch *a a*, interſecting the arch *v v*, in the point O.

F. XXXII. 2. Draw from the interſection O, the right lines A O, and B O, and they will complete the equilateral triangle whoſe ſides are each equal to the given line N M, as required.

Problem XIV.

Three unequal right lines, as R S T, *being given to make a right lined triangle, whoſe ſides ſhall be equal thereunto.*

1. Make A B, equal to R.

2. Take the line S in your compaſſes, and on A deſcribe the arch *a a*.

3. Take the line T in your compaſſes, and on B deſcribe the arch *m m*, interſecting the firſt arch in the point C. Fig.

4. Draw from the interſection C, the right lines C A and C B, and they will complete the triangle, whoſe ſides are reſpectively equal to the given lines R S T, as required.

A B, A C, C B } equal to the given line { R, S, T

Problem XV.

To deſcribe a geometrical ſquare, whoſe ſides ſhall be equal to a right line given.

Let it be required to make the geometrical ſquare M N O P, whoſe ſides ſhall be reſpectively equal to the given line A B.

1. Make O P equal to A B. Fig. XXXIV.

2. On the point P erect the perpendicular P N, (by problem III, or IV, hereof) and make it equal in length to the given line A B.

3. With the diſtance A B, on the point N, deſcribe the arch *n n*, and with the ſame diſtance, on the point O, deſcribe the arch *a a*, interſecting the former in the point M.

4. From M the point of interſection, draw the right lines M N and M O, and they will complete the geometrical ſquare, as required.

Problem XVI.

To make an oblong parallelogram, or long ſquare, as A B C D, *whoſe length and breadth ſhall be equal to two given lines, as* N O.

1. Make the line C D, equal to the given line O, and on D, (by the IIId problem hereof) erect the perpendicular B D, and make it equal to the given line N. Fig. XXXV.

2. On B, with the diſtance C D, deſcribe the arch *o o*, and on the point C, with the diſtance B D, deſcribe the arch *r r*, interſecting the former in the point A.

3. From A the point of interſection, draw the right lines A B and A C, and they will complete the oblong, as required

The ſide A B and C D } is equal to the right line { O
The ſide A C and B D } { D

Problem XVII.

To make a rhombus, or diamond form, whoſe ſides ſhall be equal to a right line given.

Let it be required to deſcribe the rhombus A, M, N, O, whoſe ſides ſhall be each equal to the given line V, R.

Fig. XXXVI. 1. Make A O equal to V R, and on the point O, with the diſtance O A, deſcribe the arch A M N.

2. With the ſame diſtance ſet up the opening of the compaſſes from A to M, and from M to N.

3. From the point A to the point M, draw the right line A M, and from the point M, draw the right line M N to the point N; and laſtly, draw the line N O, and you will complete the rhombus as required, with its reſpective ſides equal to the given line V R.

Problem XVIII.

To make a rhomboyades, whoſe ſides ſhall be equal to two given right lines, as L *and* Q; *and the acute angles at* M *and* O, *equal to the given angle* Z.

1. Make P M equal to the given line L, and by problem VII, make the angle E M P, equal to the angle Z, and make M E equal to the given line Q.

Fig. XXXVII. 2. Take in your compaſſes the given line L, and on E, deſcribe the arch *n n*.

3. Take the length of the other given line Q, and on the point P, deſcribe the arch *a a*, interſecting the former in the point O.

4. From O the point of interſection, draw the lines O E and O P, and they will conſtitute the rhomboyades as required, whoſe ſides O E and P M, ſhall be equal to the given line L, and the ſides O P and E M, equal to the given line Q, as alſo the angles at O and M, equal to the given angle Z.

Problem

Problem XIX.

To make a trapezium (*as the figure* R N O M) *whoſe ſides ſhall be equal to four right lines given, as the lines* D, E, V, T, *and one angle, as the angle* N, *equal to an angle given, as the angle* Z.

1. Make N M equal to the given line D, and by problem VII. make the angle at N, equal to the given angle Z, and make N, R, equal to the given line E.

2. Take the given line V in your compaſſes, and on M deſcribe the arch *n n*, then take the given line T, and on R deſcribe the arch *a a*, interſecting the former arch in the point O. Fig. XXXVIII.

3. From the point of interſection O, draw the right lines O M and O P, and they ſhall complete the trapezium, as required, with its reſpective ſides equal to the lines given.

Problem XX.

How to deſcribe an ellipſis to any length and breadth given, as the figure A B C M, *whoſe longeſt diameter is equal to the given line* D V, *and the ſhorteſt to the line* E P.

1. Make the right line A C equal to the given line D V, and (by problem I.) divide it into two equal parts, by the perpendicular B M, which make equal to the given line E P.

2. Take half the longeſt diameter, as A F or C F, and on B deſcribe the arches *a a*, and *a a*, interſecting the longeſt diameter in the points O and N, which are the two centers by which the ellipſis may be deſcribed. Fig. XXXIX.

3. Faſten two pins, or tacks, (if on the ground, as in a garden, two ſtakes) at O and N, and putting a line about them, faſten the ends together, at the length of the line O C, or N A, ſo that the ſtring may move about both the pins, tacks, *&c.* at pleaſure.

4. Take a black-lead pencil, tracer, *&c.* and extending the line therewith, it will, by its motion about thoſe two centers, deſcribe an ellipſis, as ſhall be equal in length and breadth to the given lines D V and E P, as required.

Problem XXI.

How to deſcribe an ellipſis to any length and breadth, as the figure A B C D, *whoſe longeſt diameter is equal to the given line* M, *and the ſhorteſt to the line* N, *by the help of a pair of compaſſes, without the aſſiſtance of a line and tracer, as in the preceding problem.*

1. Deſcribe the longeſt and ſhorteſt diameters, equal to the given lines, interſecting each other, at right angles in the point E (as in the preceding).

2. Take half the ſhorteſt diameter, as B E, and place that diſtance from A to F on the longeſt diameter.

3. Divide the ſpace between F and E the center, into
Fig. XL. three equal parts, and place one of thoſe parts backward from F to I.

4. Make E K equal to E I, and on K, with the diſtance K I, deſcribe the arches *n n* on the one ſide, and *n n* on the other.

5. With the ſame diſtance, on the point I, deſcribe the arches *o, o,* and *o, o,* interſecting the other two in the points L and M.

6. Lay a ruler from L to I, and draw the line I V; alſo from L to K, and draw the K P; alſo from M to K, and draw the line K Q; and alſo from M to I, and draw the line I R.

7. On I, with the diſtance, I A deſcribe the arch *z* A *z*, and on K, with the ſame opening, deſcribe the arch *x* C *x*.

8. On M, with the diſtance M *z*, deſcribe the arch *z* B *x*; and on L, with the ſame opening, deſcribe the arch *x* D *z*, and thus is the ellipſis completed, as required.

Problem XXII.

To inſcribe a circle within a ſquare.

Fig. XLI. 1 Draw the diagonals N S and V M, interſecting each other in the point O.

2. From the point O, let fall the perpendicular O C, and with the opening O C on O, deſcribe the circle as required.

Problem XXIII.

To inſcribe a ſquare within a circle, and to circumſcribe a circle about a ſquare.

1. By the third of problem XII. inſcribe the ſquare A E I O, and draw the diagonals A O and E I, interſecting each other in the point N. Fig. XLII.

2. On N, with the diſtance N A, N E, N I, or N O, (they being all equal to each other, by definition 11. fig. VII.) deſcribe the circumſcribing circle, as required.

Problem XXIV.

To inſcribe a circle within a triangle, as the circle M, o, e, *within the equilateral triangle* A E N.

1. Divide any two of the angles of the given triangle, as the angle N and A, into two equal parts, by the lines N *o* and A *e*, interſecting each other in the point M, (as by problem VIII. hereof). Fig. XLIII.

2. From M let fall the perpendicular M P; and on M, with the diſtance M P, deſcribe the inſcribed circle, as required.

Problem XXV.

To circumſcribe a circle about a triangle.

The ſolution of this problem is exactly the ſame as problem XI. For if you ſuppoſe the three angular points B C A, to be three given points, *&c.* as in that problem, the operation hereof is exactly the ſame, and therefore needs no further demonſtration. Fig. XLIV.

Problem XXVI.

To find the center of a circle, that ſhall paſs through any two given points within a circle, and divide the circumference into two equal parts.

Let M N be the given points.

1. From any one of the points as M, draw a right line through the center O, extending it infinitely to Æ. Upon this line, at the center O, erect the perpendicular
Fig. XLV. O W, and from W through M, draw the line W R; and from R, through O the center, draw the diameter R, O, *a*.

2. Draw the right line W *a*, and extend it till it interfect the line M O Æ, in the point V; through which, and the given points M and N, you may deſcribe the arch of a circle (by problem XI.) as will divide the circumference given into two equal parts, and paſs through the two given points, as required.

Problem XXVII.

To make a geometrical ſquare, as A E M N, *equal in area to any right lined triangle, as the triangle* I O M, *given.*

1. Let fall the perpendicular O R, and make M S equal to half the perpendicular O R.

Fig. XLVI. 2. Divide I S into two equal parts at R, and on R, with the diſtance I R, or R S, deſcribe the ſemicircle I A S.

3. At M erect the perpendicular M A, and extend it till it interſect the ſemicircle in A.

4. The line A M is the ſide of a geometrical ſquare, whoſe area is equal to the area of the triangle given, as required.

Problem XXVIII.

To make a geometrical ſquare, equal to a parallelogram given.

Let it be required to make a geometrical ſquare equal in area to the oblong, or parallelogram, A B C D.

Fig. XLVII. 1. Continue the ſide C D to F, making D F equal to BD, and divide C F into two equal parts at G, and thereon, with the diſtance G C, or G F, deſcribe the arch C E F.

2. Continue D B to E, and then will D E be a mean proportional, and the ſide of a geometrical ſquare, whoſe area is equal to the oblong, or parallelogram, A B C D given, as required.

Problem

Problem XXIX.

To divide a line given, in ſuch proportion as another is before divided.

Let it be required to divide the right line M, in ſuch proportion as the line A E.

1. By problem XIII. hereof, make the equilateral triangle G H I, with its ſides equal to the line A E, and divide any one ſide thereof, as H I, in the ſame proportion, as A E (the length being equal).

2. Take the length of the line M, and ſet it from G (the angle oppoſite to the ſide divided) to V, on one ſide, and to O, on the other ſide, and draw the right line V O. Fig. XLVIII.

3. Lines being drawn from G, thro' the points 1, 2, 3, 4, 5, and 6, ſhall interſect the line V O, in the points o o o, &c. and divide that line in the very ſame proportion as the given line H I, as was required.

Problem XXX.

To divide the circumference of any circle into 360 *equal parts, as the circle* A B C D, *fig.* XLIX.

1. Draw the diameter A C, and by problem I. divide it into two equal parts by the perpendicular B D, then will the circle be divided into four equal parts, and conſequently the circumference alſo.

2. Open your compaſſes to half the diameter, as P A, &c. and ſet that diſtance, *firſt*, from A to *e*, and from A to *f*; *ſecondly*, from B to *m*, and from B to *l*; *thirdly*, from C to *k*, and from C to *i*; *laſtly*, from D to *h*, and from D to *g*; and thus you have divided the circumference into 12 equal parts, each repreſenting 30 degrees.

3. Divide each of thoſe diviſions into three equal parts, and each of thoſe parts into ten, and then will the circle be divided into 360 equal parts, which are called degrees. It is to be obſerved herein, that the ſemi-diameter, which is generally called the radius, is always equal in length to 60 degrees, or equal parts of the circumference. Every equal part (or degree) of the circumference, is always ſuppoſed to be divided into 60 leſſer e- Fig. XLIX.

qual parts, and thoſe are term'd or called minutes. Therefore when we mention two degrees and a half, we ſay two degrees 30 minutes; or one deg. and $\frac{1}{3}$, we ſay one degree and 20 min. and when we write down any number of degrees and min. as thirty degrees fifty ſeven minutes, we write them thus 30° : 57′, &c. And what is here ſaid in the diviſion of the circumference of this circle, the ſame is to be underſtood in the diviſion of the circumference of every circle, for in the circumference of every circle, there is always the ſame number of degrees therein, although ſome circles may be ſmaller, and others larger than the given circle A B C D.

Demonſtration.

1. Draw right lines from the center P, through every tenth degree of the circumference, and extend them infinitely.

2. On P the center, deſcribe the inward circle, and the lines before drawn through every tenth degree, will interſect that circle in the points *n n n*, &c. and will divide that circumference into thirty ſix equal parts, each repreſenting 10 degrees. Alſo on P deſcribe the outward circle *o o o o*, &c. wherein you may obſerve the aforeſaid lines of every tenth degree, to divide that circumference
Fig. XLIX. in the very ſame proportion, as the inward circle *n n n n*, &c. and the given circle A B C D. Therefore let any circle be as ſmall as may be conceived, or as large as the greateſt circle as can be ſuppoſed to bound the univerſe, the number of degrees in each are both equal, and conſequently the minutes the ſame, though greater or leſſer each, in ſuch proportion as the circumference of one circle hath to another, which is what was to be demonſtrated.

N. B. Before the young ſtudent proceeds any further, let him well underſtand this problem, for hereon the whole body of mathematicks depends, as alſo the ſeveral operations following; but if he finds any difficulty upon the firſt or ſecond reading, either of this or any other problem, let him not be diſcouraged, 'twill by often contemplating be made eaſy; for mathematicks, is not to be underſtood at once reading over, like plays, hiſtory, or romances.

Problem XXXI.

To inſcribe an ellipſis within an oblong, or parallelogram, as A B C D.

1. Draw the two diameters of the parallelogram, as E G and F H, which ſuppoſe to be the length and breadth of an ellipſis given, to deſcribe the ſame as if they had not been the diameters of the oblong. Fig. L.

2. By problem XX, or XXI, deſcribe the ellipſis E F G H, and it will be the ellipſis inſcribed, as required.

Problem XXXII.

To erect a perpendicular line by the help of a ten foot rod (or other meaſure equally divided) on the ground, in the ſetting out of a building, garden, &c.

The proportional numbers contained in a ſquare, or right angle, is 3, 4, and 5; or 6, 8, and 10; therefore if you would raiſe the perpendicular D F, from the point D, on the line H D; ſet off ſix foot from D to E, and with eight foot of your rod at D, deſcribe the arch *a a*; and alſo with ten foot, deſcribe the arch B B, on the point E, and the interſection F is the perpendicular point required: or, from E lay a ten foot rod, and from D an eight foot rod, and cloſe their ends together, and that ſhall be the perpendicular point alſo; and a right line drawn from thence to D, ſhall be the perpendicular required.

This problem may be applied to practice on paper, if you uſe a ſcale of equal parts, and a pair of compaſſes inſtead of the ten foot rod.

SECT. III.

Of *Geometrical* Axioms *and* Theorems.

PLATE IV.

AXIOM I.

IF to, or from, equal quantities, be added or ſubtracted equal quantities, the ſums or remainders will be equal.

Demonſtration.

Fig. I. 1. Draw the two diameters A F and L B, interſecting each other in the center N, and then will the angle A N L be equal to the angle B N F, for the arches A B and B F completes a ſemicircle, as alſo do the arches B A and A L. Therefore the arch B F muſt be equal to the arch A L, becauſe the arch A B continues the ſame; and by the ſame reaſon the angle A N B, is equal to the angle L N F.

AXIOM II.

Quantities equal to a third, are equal to one another.

Demonſtration.

Fig. II. The alternate angles C and F, are equal to each other, as alſo E and D; for the angle C is equal to the angle B, and the angle B to the angle F, by the preceding axiom. Wherefore C and F being both equal to B, muſt be equal to one another, and the like of E and D, which are both equal to the angles A and G.

Theorem I.

If a right line do fall on two parallel right lines, it maketh the oppoſite angles equal, and the internal angles on the ſame ſide, equal to two right angles, or 180 *degrees.* Fig. II.

1. The right line P Q, falling upon the two parallel right lines R T and S V, do make the angle D equal to A, and C to B, alſo the angle G equal to E, and H to F.

2. the angle D with F is equal to two right angles, becauſe F is equal to C (by axiom II.) and C and D together are equal to two right angles, or a ſemicircle; and ſince the angle F is equal to the angle C, therefore F D or E C, are equal to two right angles, or 180 deg. which was to be proved.

Theorem II.

If multifarious right lines be interſected by multifarious right lines, which are parallel one to the other, the ſegments are proportional one to the other. Fig. III.

Demonſtration.

Let the right lines N O and N M, be interſected by the ſix parallel right lines T T, V V, X X, Y Y, Z Z, and W W; then will the interſegments be proportional one to the other. For if N A be one fifth part of N O, N B is likewiſe one fifth part of N M, and the like of all others.

Theorem III.

If four right lines be proportional, that is, as the firſt is to the ſecond, ſo is the third to the fourth; the parallelogram made of the two means (or middle terms) will be equal to the parallelogram made of the extreams. Fig. IV.

Demonſtration.

Let the four proportionals be A 24, B 16, C 12, and D 8; I ſay, the parallelogram made of the two mean terms,

terms, *viz.* 16 and 12 is equal to the parallelogram made of the two extreams, *viz.* 24 and 8. Therefore multiply 16 by 12, and the product is equal to 192, and alſo 24 by 8, and the product is equal to 192, as before. Therefore 'tis apparent, that the parallelogram made of the means, is equal in power to the parallelogram made of the extreams, which was to be demonſtrated.

Theorem IV.

If three right lines be proportional, viz. *as the firſt is to the ſecond, ſo ſhall the ſecond be to a fourth. The ſquare made of the means ſhall be equal to the oblong made of the extreams.*

Demonſtration.

Fig. V. Let the proportional lines or numbers be 4, 8, 8, then will it be as 4 is to 8, ſo is 8 to 16, and the ſquare A E I O of the means, will be equal to the parallelogram, made by the extreams. For multiplying the means 8 by 8, the product is 64, and multiplying the extreams 4 and 16 by each other, the product is 64, and is equal to the product of the means which was to be demonſtrated.

Theorem V.

In every right angled plain triangle, the ſquare made of the hypothenuſe, or ſide which is oppoſite to the right angle, is always equal to the ſum of the ſquares made of the legs or ſides.

Demonſtration.

Fig. VI. Let N O M be a right angled plain triangle, whoſe ſides are as follows, *viz.* the ſide N M equal to 6, and the ſide M O equal to 8, then will the hypothenuſe be equal to 10.

2. If you multiply the ſide N M into itſelf, its product will be equal to 36, the ſquare N D M I.

3. Multiply the ſide M O into itſelf, and its product will be equal to 64, the ſquare M O V C.

4. Add

4. Add the area of both ſquares together, *viz.* 36 and 64, and their ſum will be equal to 100.

5. Multiply the hypothenuſe NO into itſelf, and its product is 100, which is equal to the ſum of the ſquares made of the legs before added together, as was to be demonſtrated

SECT. IV.

PLATE. II.

Of the *Conſtruction* of *Compound Geometrical FIGURES.*

I. *General AXIOMS for the proportions of figures.*

AXIOM I.

THat the length of a proportionable parallelogram be to the breadth, as three is to two; therefore if the length be three foot, the breadth muſt be two foot.

AXIOM II.

When a geometrical ſquare hath its ſides intercepted with ſemicircles externally, as A, the diameter of every ſuch ſemicircle muſt contain $\frac{5}{7}$ of the ſide, on which 'tis deſcribed; and the ſame proportion alſo, when at the end of a parallelogram, as B. Fig. IX.

AXIOM III.

When the angles of a geometrical ſquare, or oblong, is cut off by the arch of a circle, the radius of thoſe quadrants, or arches, muſt be $\frac{1}{7}$ the length of the ſide of a geometrical ſquare, or end of the parallelogram, and the ſame proportion is to be obſerved when the angles are

cut off by a ſmall geometrical ſquare, as the fig. C cut by little ſquares, and D by quadrants or arches.

Axiom IV.

When the ſide of a geometrical ſquare, or end of a parallelogram, hath its angles cut off by arches or little ſquares, and the $\frac{5}{7}$ remaining be intercepted by a ſemicircle, as E F; the arches, or little ſquares, muſt be firſt deſcribed, and the diameter of the ſemicircle muſt contain $\frac{5}{7}$ of the remainer, as the ſemicircle in axiom II. contains $\frac{5}{7}$ of the whole breadth.

Axiom V.

When the angle of a geometrical ſquare, or oblong, is cut off by a part of a geometrical ſquare, and the quadrant of a circle, as fig. G; the radius of thoſe arches, or quadrants, muſt contain $\frac{3}{4}$ of the ſide of each little ſquare.

Axiom VI.

Fig. IX. When a compound figure is circumſcribed by a compound figure, thoſe arches of the compound figure circumſcribing, muſt contain $\frac{1}{3}$ of that ſide to which they belong, ſo *a*, *b*, contains $\frac{1}{3}$ of C D in figure H; but the center of all ſuch arches muſt always be upon the internal fig. as at *m*.

Axiom VII.

When any ſide of a right line figure has a ſquare break therein, as the figure T at V; the length of that break muſt be $\frac{3}{5}$ of A B, (*viz.* the length of the ſide wherein it ſtands) and the depth $\frac{1}{5}$; but when a break happens againſt an arch, as at O, in figure T T, thoſe breaks muſt be made in proportion to the curve of the oppoſite arch.

Axiom VIII.

When an arch breaks into an oblong, as the arches *m m* in figure T T, it muſt not break in above $\frac{1}{5}$ of the breadth of the oblong at moſt, and the extreams of ſuch an arch muſt ever be five times their depth. They are

to

to be deſcribed by problem XI. ſect. I. having the depth, and both extreams given, as three given points.

Axiom IX.

When the ſides of a geometrical ſquare is intercepted with ſemicircles internally, as figure Z; the diameters of thoſe ſemicircles muſt be no more than one half the ſide of the ſquare, wherein they are deſcribed. Fig. IX.

Theſe axioms, and the preceding problems of ſect. I. being well underſtood, the young ſtudent will find no ſort of difficulty in deſcribing the figures contain'd in the eight enſuing problems, to which we will proceed

A *general Rule concerning Compound Figures.*

THAT every compound (or plain) figure, that is encompaſs'd with another figure, be not of the ſame kind, *viz.* not to incompaſs an octagon with an octagon, but with a circle, or ſome other figure as is agreeable thereunto, and the like of all other figures in general.

Problem I.

To deſcribe the compound figure A B C D, *with its circumſcribing figure* E F G H.

1. By problem XV. ſect. I. deſcribe the geometrical ſquare A B C D. Fig. I.
2. By axiom II. hereof, deſcribe the quadrants of each angle, and thus will the interior figure be completed.
3. At the parallel diſtance aſſign'd, draw the ſquare E F G H, by problem VI. ſect. I. and by axiom VI. hereof; deſcribe the arches *o*, *o*, *o*, *o*, whoſe centers are at *e*, *e*, *e*, *e*, and they will complete the figure required.

Problem II.

To deſcribe the compound figure A B C D, *with its circumſcribing figure* E F G H.

1. By problem XV. ſect. I. deſcribe the ſquare A B C D, in ſuch proportion as is laid down in axiom I. hereof, and by axiom III. deduct the little ſquares from every angle.

Fig II. 2. Deſcribe the outer parallelogram parallel to the firſt at the diſtance aſſign'd, and by axiom VI. deſcribe the four arches H, G, F, E, whoſe centers are at *a a a a*, and they will complete the figure required.

Problem III.

To deſcribe the compound figure A B C D, *with its circumſcribing figure.*

Fig. III. 1. By problem XV. ſect. I. deſcribe the geometrical ſquare ABCD, and by axiom II. hereof, deſcribe the ſemicircles, and then by drawing the circumſcribing line parallel thereunto, at any diſtance aſſign'd, the figure is completed as required.

Problem IV.

To deſcribe the compound figure A B C D, *with its circumſcribing figure.*

Fig. IV. 1. By problem XVI. ſect. I. deſcribe the parallelogram, according to the proportion of axiom I.

2. By axiom III. cut off the angles with the quadrant of a circle, and by axiom II. deſcribe the ſemicircles at each end, whoſe centers are *e e*.

Laſtly, Deſcribe the circumſcribing figure parallel thereunto, at any diſtance aſſign'd; and the figure is completed, as required.

Problem V.

To deſcribe the compound figure A B C D, *with the circumſcribing figure* E F.

1. By

1. By problem XVI. ſect. I. deſcribe the parallelogram A B C D, according to the proportion of axiom I. and deſcribe the ſemicircles at the ends, according to axiom II. Fig. V.

2. Deſcribe the outward line parallel thereunto at any diſtance aſſigned; and by axiom VII. deſcribe the breaks E F, and the figure is completed as required.

Problem VI.

To deſcribe the compound figure A B C D, *and its circumſcribing figure* E F G H.

1. By problem XV. ſect. I. deſcribe the geometrical ſquare A B C D, and by axiom V. deſcribe the angles. Fig. VI.

2. At any aſſigned diſtance deſcribe the outer ſquare E F G H; and by axiom VII. deſcribe the quadrants at every angle.

Laſtly, By axiom VI. deſcribe the arches K M N L, and the figure is completed as required.

Problem VII.

To deſcribe the compound figure A B C D, *and its circumſcribing figure* E F G H.

1. By problem XV. ſect. I. deſcribe the geometrical ſquare A B C D, and by axiom II. deſcribe the ſemicircles whoſe centers are *a a a a*; and by axiom III. deſcribe the arches at every angle. Fig. VII.

2. At any parallel diſtance aſſign'd, deſcribe the ſquare E F G H, and at the ſame parallel diſtance, deſcribe the arches I K L M, and the figures will be completed as required.

Problem VIII.

To deſcribe the compound figure A B C D, *with its circumſcribing figure* E K F L H M G I.

1. By problem XV. ſect. I. deſcribe the geometrical ſquare A B C D, and by axiom IX. deſcribe the ſemicircles *a a a a*. Fig. VIII.

2. At any parallel diſtance aſſigned, deſcribe the ſquare E F G H; and by axiom VII. deſcribe the breaks K L M I; and by axiom III. the arches at the angles E F G H, which will complete the figure as required.

Theſe foregoing eight inſcribed figures, are very beautiful forms for fountains, baſons, fiſh-ponds, graſs-plots, or ornaments of cockle-ſhells, ſand, borders, &c. about a ſtately tree of yew, holly, philerea, lauruſtinus, &c. or ſtatue. Provided that you have the advantage of a terrace-walk, or mount, to view the ſame, otherwiſe a plain plot of graſs is far preferable.

And to complete the idea and practice of ſuch figures in gardening, I have, for the exerciſe of the young ſtudent, and variety of choice, for all gentlemen as delight therein, inſerted the ſeveral forms in figure X. which are in general deſcribed by the preceding rules, and may not only prove a great help to invention, but alſo of uſe to many gentlemen in forming ſuch parts of their gardens (as they relate to) in the moſt elegant manner. Fig. X.

Thoſe figures marked A A, &c. are varieties of the interſections of gravel, ſand, and graſs walks with proper centeral plots, or figures, to place ſtatues on pedeſtals in, as alſo the forms of the ends of parterres, or graſs-plots, as circumſcribe the ſame.

Thoſe figures marked B B, &c, are niches, or breaks in hedges, walls, &c. for to place publick ſeats of delight in, at the termination of an elegant walk, avenue, &c. And,

Thoſe marked D D, &c. are the forms of cabinets, or private places of retirement, in the moſt private retired parts of a wilderneſs, labyrinth, grove, &c.

N. B. That although hitherto I have recommended theſe compound figures in gardening only; yet the ingenious ſtudent in architecture is to obſerve, that they are exceeding beautiful in building, as in cielings, parrquetting, painting, paving, &c.

SECT.

SECT. V.

Of the Conſtruction of the ſingle, double, &c. ſpiral Line, Scroll, Artinatural Line, &c. for Practice in Gardening.

PROBLEM I.

PLATE III.

TO deſcribe a ſingle ſpiral line at any aſſigned diſtance.

Let it be required to deſcribe the ſingle ſpirial line, at the diſtance of the given line *i k.* Fig. I.

1. Draw a right line, as A B, and on any convenient point of the ſame, as at *c*, deſcribe a circle of ſuch a diameter as is aſſigned.

2. Take half the given line *i k*, and place that diſtance from *c* the center, to *b* and *d* on each ſide hereof, which points, *b* and *d*, are the two centers, on which the double ſpiral line will be deſcribed.

3. Take the diſtance *d a*, and on *d*, deſcribe the ſemicircle *a f*.

4. Take the diſtance *b*, *f*, and on *b*, deſcribe the ſemicircle *f h*.

5. Take the diſtance *d h*, and on *d*, deſcribe the ſemicircle *h g*; and ſo by moving your compaſſes firſt to the other center *b*, and afterwards to *d*, &c. you may continue the ſpiral line about infinitely, which is what was required to be performed.

PROBLEM II.

To deſcribe a double ſpiral line at any diſtance aſſigned.

Let it be required to deſcribe the double ſpiral line, at the diſtance of the given line *m*, *n*. Fig. II.

1. Draw

Of the *Conſtruction* of the

1. Draw a right line, as A B, and on any convenient point of the ſame, as at *a*, deſcribe a circle of ſuch a diameter as is aſſign'd.

2. Take half the given line *m*, *n*, and place that diſtance from *a* the center, to *b* and *c* on each ſide thereof, which points, *b* and *c*, are two centers, on which the double ſpiral line will be deſcribed.

3. On *c*, with the diſtance *c*, *e*, deſcribe the ſemicircle *e*, *ſ*, *d*.

4. On *b*, with the ſame diſtance, deſcribe the ſemicircle *m*, *n*, *f*.

5. On *c*, with the diſtance *c f*, deſcribe the ſemicircle *f r g*, and then you will have got the double line equal; therefore, if you remove your compaſſes to the other center *b*, you may thereon, with the diſtance *b d*, deſcribe the ſemicircle *d*, *o*, *h*, and on the ſame center, the ſemicircle g P *i*, and then by removing again, firſt to *c*, may deſcribe the ſemicircles *h*, *u*, *k*, and *i*, Q, *l*, &c. as in the preceding problem, which is what was to be demonſtrated.

Problem III.

To deſcribe the compound line, called the running worm.

This line may be deſcribed in two manners, *viz.* on a right line, as A B, or on a ſpiral line, as N K I G E.

I. *To deſcribe the runing worm on a right line.*

Practice.

1. Draw the right line A B, and on *a*, with any convenient opening (that will not deſcribe an arch with too ſharp a turning to create giddineſs in walking) deſcribe the arch A *b*, and with the ſame opening, turn your compaſſes from *b* to *c*, and on *c*, deſcribe the arch *b d*; and then turning them *d* to *e*, deſcribe the arch *d f*, and in the like manner all the others contain'd in the line A B. When this line is applied to any uſe as requires breadth, as a walk through a wood, &c. that breadth may be deſcribed upon the ſame centers, as the line it ſelf, and in the very ſame manner.

Fig. III.

II. *To*

II. *To deſcribe the running worm on a ſpiral line.*

Practice.

1. By the preceding problem, deſcribe the double ſpiral line F G, H I, K L, M N; and on E *a*, deſcribe the ſemicircle, or rather arch *b c*, and on the ſame center, the arch *d*, *e*, *f*.

2. With the former opening *b a*, turn the compaſſes from *c* to *g*, and on *g*, deſcribe the arch *c h*, and alſo the arch *f i*; and with the ſame openings and manner of working the other arches, and their parallels, muſt be deſcribed. And as this running worm is deſcribed but on one of the two ſpiral lines, therefore by giving the other the ſame parallel breadth as the running worm, and uniting them together at Z and F, 'twill create a variety in walking, and unexpectedly bring out the perſon, at his place of entrance, contrary to his expectation. Fig. IV.

Problem IV.

To deſcribe a treble ſpiral line at any diſtance aſſign'd.

Let it be required to deſcribe the treble ſpiral line at the diſtance of the given line *m*, *n*,

1. By problem XIII. ſect. I. deſcribe the equilateral triangle A B C, and make the ſides thereof each equal to the given line *m*, *n*, and from the center thereof, through every angle, draw the right lines B D, C D, and A D.

2. On A, with the diſtance A C, deſcribe the arch *c d e*, and with the ſame opening on B, deſcribe the arch A *f g*; and alſo on C, deſcribe the arch B *h i*. (And here you muſt note, that in this and all other figures of this kind, the ſeveral arches therein that compoſe the whole muſt not be continued in one arch of a circle any farther than from one line of direction to another, be there one, two, three, four, &c. *viz.* in this figure; for example, no arch muſt be deſcribed at one ſweep, no farther than from the line of direction A D to the line of direction C D, or from the line of direction C D to the line of direction B D; Fig. V.

and the like from the line of direction B D to the line of direction A D.

3. On A, with the diſtance A *i*, deſcribe the arch *i k l*; and with the ſame opening on the point B, deſcribe the arch *e m n*; and alſo on the point C, deſcribe the arch *g, o, p*.

4. On the point A, with the diſtance A *p*, deſcribe the arch *p, t, u*; and with the ſame diſtance on B, deſcribe the arch *l, q, u*; and alſo on the point C, deſcribe the arch *n r s*; and in the like manner on the three points A B and C, you may encreaſe the magnitude thereof, as much as deſired, which is what was required to be done.

Theſe treble ſpiral lines, are exceedingly beautiful, when planted with hedges of hornbeam, engliſh-elm, &c. and the whole environ'd with a wood, wherein may be deſcribed divers other walks (as thoſe marked F F, &c.) that be made to unite with the three ſeveral walks of the ſpiral line, as at D D D.

Thoſe walks marked F F, are what I call artinatural walks by reaſon they are deſcribed by art, and repreſent the product of nature, which in all woods and wilderneſſes ſhould be imitated as near as poſſible, which hitherto, by deſigners of gardens, as the late Mr. *London*, his followers, &c. has never been thought of, or practiſed, they always obſerving a ſtiff heavy regular form equal in all other parts alike; ſo that when any perſon had ſeen one quarter of any of their gardens, they had then, in effect, ſeen the whole, the remaining three parts being but the firſt repeated ſo many times, and thoſe ſtuff'd up with their evergreens at ſuch a rate, that they ever had an aſpect more like unto a nurſery than a pleaſant garden, as intended.

The beauty of a garden (in my humble opinion) conſiſts in a regular, irregularity, that the parts may appear as equal, and at the ſame time be unequal among themſelves, and thereby, at every ſtep forward, a new ſcene, or freſh object appears, and the whole becomes an everlaſting entertainment.

But ſince this treatiſe is not particularly deſign'd for gardening, I ſhall therefore forbear, and return to problem V.

PROBLEM

Problem V.

To deſcribe a quadruple ſpiral line at any diſtance aſſign'd.

Let it be required to deſcribe the quadruple ſpiral line at the diſtance of the given line H I.

1. By problem XV. ſect. I. deſcribe the geometrical ſquare 1 2 3 4, and make each ſide thereof equal to the given line H I.

2. Divide each ſide thereof into two equal parts, and draw the diameters, extending them infinitely; as from A the center, to B C D and E.

3. On A the center, deſcribe the circle *e b c d*, of ſuch diameter as ſhall be aſſign'd.

4. The points 1 2 3 and 4, being the centers on which the whole is deſcribed; therefore, on the point 1, with the diſtance 1 *d*, deſcribe the arch *d a*; and with the ſame diſtance on 2, deſcribe the arch *b f*; and alſo on 3, deſcribe the arch *e g*; and likewiſe on 4, deſcribe the arch *c h*. Fig. VI.

5. Begin again, and on the point 1, with the diſtance 1 *h*, deſcribe the arch *h i*; and with the ſame diſtance on the center 2, deſcribe the arch *a k*; and alſo on 3, deſcribe the arch *f l*; and likewiſe on 4, deſcribe the arch *g m*; and then begining again at the center 1, with the diſtance 1, *m*, &c. you may deſcribe the four lines to any magnitude required.

This kind of figure may at laſt be circumſcribed in a circle (as in the figure) when 'tis applied to practice on the convexity of a mount, or concave, as that of the Honourable *Thomas Vernon*'s, in the gardens of his ſeat at *Twickenham Park* in the County of *Middleſex*, made by me in the year 1722. This concave was a large ſand-pit, and then a perfect nuſance, and ſuppoſed to be incapable of any improvement as would be agreeable to the circumjacent parts of the gardens, then new made: but when I deliver'd a draught of the ſame, the former ſuppoſition was deſtroy'd, and 'twas then demonſtration ſufficient, that inſtead of its being a nuſance, 'twould be a very agreeable beautiful figure, as it now appears in.

And from hence it further appears, that the great expence that many noblemen and gentlemen have formerly been put to, by the indiſcreet directions of Mr. *London*, and his

emiſſaries, in removing hills to fill up ſuch concavities, to make the ground level and uniform (as they in their own terms call it) for the execution of their regular ſtuff'd up parterres, flower knots, &c. with fine finakin ſurbelow'd yews, hollies, &c. whereby the whole ever had the aſpect of a nurſery, more than a garden of delight, as I ſaid before; were not only an immenſe needleſs expence, but the garden it ſelf thereby totally ruin'd. And ſince I have here taken the liberty to mention that error, I will alſo enlarge a ſmall matter further, in relation to another, full as groſs as the preceding, *viz.* to fully execute their regular forms, cut down many a well grown ſturdy oak, elm, &c. and introduces a trifling flowering ſhrub, or ſmall tree of yew, holly, phylerea, lauruſtinus, &c. which, in my opinion, is a plain proof of their ignorance of the ſcience, as well as a crime almoſt unpardonable. But to return to problem VI.

Problem VI.

How to deſcribe an elliptical ſpiral line about an ellipſis given.

Let it be required to deſcribe about the ellipſis K M I L, the elliptical ſpiral line N O G P Q V R S T W E, at the diſtance of the given line X Y.

1. Deſcribe the ellipſis K M I L, according to problem XXI. ſect. I. and draw the lines of direction G F, G A, H C, and H E, infinitely.

2. Divide the given line X Y into nine equal parts, and take the diſtance of two of thoſe diviſions in your compaſſes, and ſet it on the line of direction G F, from D, the point of interſection, to 1, and on the ſame line from G to 2; as alſo from B to 3, and from H to 4, on the ſame line. Theſe four points 1, 2, 3 and 4, are four centers, as will deſcribe the elliptical ſpiral line, as following. Fig. VII.

1. On the point 1, with the diſtance 1, N, deſcribe the arch N, O.

2. On 4, with the diſtance 4, O, deſcribe the arch O G P.

3. On 3, with the diſtance 3, P, deſcribe the arch P Q.

4. On 2, with the diſtance 2, Q, deſcribe the arch Q V.

5. On 1, with the diſtance 1, V, deſcribe the arch V R.

6. On 4, with the diſtance 4, R, deſcribe the arch R S.

7. On 3, with the diſtance 3, S, deſcribe the arch S T.

8. On 2, with the diſtance 2, T, deſcribe the arch T W.

Laſtly, On 1, with the diſtance 1, W, deſcribe the arch W E; and in the like manner may it be deſcribed to any magnitude deſired; where any perſon deſires to have this line double, treble, quadruple, &c. they muſt proceed according to the preceding rules of the foregoing problems, and their deſires will be anſwered.

Problem VII.

To deſcribe a volutus, or ſcroll, to any magnitude required.

As for example, Deſcribe the voluta, fig. VI. with the parallel diſtance of its lines equal to the given line X X.

1. Take the length X X, and on A, deſcribe the circle D 4 C 3; and through the center A, draw the right line of direction S P.

2. Divide the diameter of the circle into four parts, as at 1, A, 2; and ſet off as many of thoſe ſmall diviſions on the ſame line of direction, without the circle (as thoſe at 6, 8, 5, 7, &c.) as are convenient for your purpoſe.

3. That being done, on the point 2, with the diſtance 2, 3, deſcribe the ſemicircle 3 E 7; and on 1, with the ſame diſtance, deſcribe the ſemicirce4 B 8.

4. On 2, with the diſtance 2, 8, deſcribe the arch 8 F G.

5. On the point 3, with the diſtance 3, 7, deſcribe the ſemicircle 7 H L, and on the ſame point, the ſemicircle K N P.

6. On the point 4, and at the diſtance 4 L, deſcribe the ſemicircle L M O; and on the ſame point the ſemicircle G I K. Fig. VIII.

7. On the point 6, with the diſtance 6 O, deſcribe the ſemicircle O Q T, and on the ſame center the ſemicircle P R S, &c. ſo that it now appears, that the oftner

'tis turn'd round, ſo many more centers muſt be added, as thoſe of 5, 7, 8, &c.

This figure has been very much uſed in parterres, flower knots, &c. but beſt for an entrance into a cabinet, or private place of repoſe in the quarter of a wood, wilderneſs, &c. And beſides all the foregoing lines of the ſix laſt problems, there is yet another, far ſuperior to any of them, when apply'd to practice in rural works, and is what (as I ſaid before) I call an artinatural line, and is to be deſcribed according to the following problem.

Problem VIII.

To deſcribe an artinatural line, in ſuch proportion as traced by hand.

It's to be obſerved, that there is no ſet form for this line, it being various according to the diſcretion of the hand that traces the ſame; therefore what is to be underſtood by this problem is, how to find the centers of ſuch arches as will deſcribe the line traced, or very near thereunto. As for example,

Fig. VIII.

Let it be required to find the centers of ſuch arches as will deſcribe the artinatural line B C D F G H K L M, &c.

1. By diſcretion, divide the ſeveral turnings, into ſuch parts as doth appear to be ſegments of circles.

2. In every ſuch diviſion make three points at pleaſure; and by problem XI. ſect. I. find the centers thereof, and deſcribe the ſeveral ſegments therein contained, and they will complete the line as required. And as the only uſe that this line can be applied to, is in pleaſant ſolitary walks of a wood, wilderneſſes, &c. therefore ſuch breadth as is aſſign'd them, may be deſcribed on the ſame centers parallel thereunto. See the diagram, wherein one view will give more inſtruction than many words.

SECT. VI.

PLATE IV.

Of the Geometrical Contruncation of the Cube, Parallelepipedon, and the ſolid Bodies generated thereby.

And in conſideration, that the following operations wholly depends upon the diviſion of a right line into extream and mean proportion; I will, therefore, firſt lay down

HOW to divide any right line (as the given right line A B) *in extream and mean proportion.* Fig. XV.

Practice.

1. Make the geometrical ſquare C D L N, with every one of its ſides equal to the given line A B.

2. On N, with the radius N D, deſcribe the arch, or quadrant, D I L.

3. Biſſect C L, C D, N L and N D, in the points O K G M, and draw the diameter K M and O G.

4. Draw the right line I M, and on M, deſcribe the arch I F, and make B P equal to M F.

5. The diſtance of B P, is the greater ſegment, and the point P, doth divide the line A B in extream and mean proportion, as required.

Of the Contruncation of ſolid Bodies.

1. The ſolid bodies generated by the ſeveral ways of cutting a cube, are the canted cube, the fruſtum of a cube, the tetraedron and its fruſtum; the octaedron, dodecaedron, icoſaedron, twelve, and thirty rhombs, of which

the tetraedron, octaedron, dodecaedron, and icoſaedron, (as likewiſe the cube) are called regular bodies, by reaſon they may be inſcribed within a ſphere. (*See* 14*th book of Euclid.*)

Cube. 2. A cube (by the 37th definition, ſect. I. part. I.) is a ſolid body containing ſix faces, each a geometrical ſquare, equal to each other, and every angle 90 degrees. This body is very eaſily made, provided every angle is an exact right angle, which in practice is very difficult to be perform'd. However, although workmen cannot be exactly mathematically true, yet they come ſo near to the truth, as not to occaſion any ſenſible difference in the operation.

Fig. VII. 3. If every face of a cube be divided, as A B C D, by an inſcribed geometrical ſquare, as E F G H, whoſe angular points divide the ſides A B, B D, D C and C A, each into two equal parts; and the triangular parts, as E A F, F B G, G D H, H C E, &c. are cut off, the re-

CantedCube. maining body is what is called the canted cube, containing 14 faces, of which ſix are geometrical ſquares, and eight equilateral triangles.

Fruſtum of a Cube. 4. If within every face of a cube be inſcribed an octagon, whoſe diameters are equal with thoſe of the face of the cube, as the octagon F G H I K L M E, and the triangular parts G B H, I D K, L C M, E A F, &c. are cut off, the remaining body is what is called the fruſtum of

Fig. VIII. a cube, containing 14 faces, of which ſix are octagons, and eight equilateral triangles.

5. Suppoſe O S be 1$\underline{0000}$, and O P the root of $\frac{2}{3}$ 8$\underline{1649}$, and O Z the root of $\frac{3}{4}$ 8$\underline{6602}$, divide Z Y into two equal parts, in the point X, and draw the triangle X S O; alſo draw the like on its oppoſite ſide, equal and oppoſite thereunto. Make O B equal to $\frac{1}{3}$ of O Z, and draw B V, pa-

Tetraedron. rallel to O S, interſecting the perpendicular X Q, in the point R, which is the vertex of the tetraedron L M N; draw the right lines V W and V T from the point V to the angles T W, and the like from the point B, to the oppoſite angles of T and W. If the triangular portions

Fig. IX. V S T, B O P, G L C, &c. are cut off, the remaining body is a priſm; whoſe ſide T V W, and its oppoſite, are each triangles, and the other three V T P B, &c. are parallelograms. *Laſtly*, by the points T R X, and the ſide of the triangle T X, drawn on the baſe, as likewiſe by the points P R X, and the other ſide of the triangle P X; divide the priſm, and thoſe parts being cut off, leaves the

the trianglar body called a tetraedron, containing four faces, and each an equilateral triangle.

6. Divide every face of the tetraedron, as Z A, *viz.* divide every ſide into three equal parts, and draw the lines *b c*, *i g* and *f d*; then will the figure *b c i g f d*, be a hexagon, and if the triangular parts *b a c*, *i h g*, *f e d*, &c. are cut off, the remaining body is called the fruſtum of a tetraedron, containing eight faces, of which four are hexagons, and four equilateral triangles. Fig. IX. *Fruſtum of a Tetraedron.*

7. Suppoſe a long cube, or parallelopipedon, as S Y C F, be as follows, *viz.* Let Q S, or W X, be equal to 10,0000, and X Y, or Q P, to the root of $\frac{2}{3}$ as aforeſaid, 8,1649, and S X to the root of $\frac{3}{4}$ more by $\frac{1}{3}$ thereof 11,5470, make X T, W V and O P, each equal to 2,8867, one fourth of X S, or Z P, and draw the right line V T, parallel to W X, and the like on its oppoſite ſide, or baſe. Fig. X.

Biſſect Q S, in R, and draw the equilateral triangle R V T, and the ſame in its oppoſite ſide, ſo that the point B, of the oppoſite triangle, be oppoſite to the point R. Draw the right lines V Z, V O and Q V, and the like on the oppoſite ſide, and cut off the triangular parts T V Z Y downwards, and its oppoſite O P Q S, upwards; then will there remain two equal parallelograms V T S R Q and O Z B Y. *Laſtly*, cut off O V R and T R above, and O V B and T B by the triangle beneath, and thereby, at ſix cuts, will be made a ſolid of eight equal faces, each an equilateral triangle, called an octaedron. Fig. X. *Octaedron.*

8. Divide each ſide of a cube into two equal parts, as D K by *q d*, H G by *g i*, &c. make D *q*, or H *g*, &c. the radius equal to 10,0000, and divide them by extream and mean proportion. Then will D *a*, F *e*, &c. be equal to 6,1803 the greater ſegment, and *e i*, *m d*, &c. to 3,8197 the leſſer ſegment. From the greateſt ſegment of one ſide to the middle of the other, draw right lines, as from *m* to E, from *o* to *i*, from I to *g*, from *e* to *d*, &c. *Laſtly*, If you cut off each triangular priſm, as E B *m r*, I *o g i*, *a e q d*, &c. at 12 cuts, will be framed a ſolid, containing 12 equal faces, each a pentagon, called a dodecaedron. Fig. XI. *Dodecaedron.*

9. Divide each ſide of a cube into two equal parts, as B C, by the right line *p b e d*, &c. interſecting each other, at right angles, as the right lines *b d* and *a c*, in the point *e*, make *e p*, &c. the radius equal to 10,0000, and let *e b*, *c a*, *e d*, and *e c*, be each equal to 6,1803 and through the points *a b c d*, draw the four right lines *a b*, *b c*, *c d*, and Fig. XII.

d a, extending each of them to the exteriour lines of the face, A B, B C, C E, and E A. Divide every face in the ſame proportion, and thereby is conſtituted eight equilateral triangles marked in the diagram 2, 3, 4, 5, 6, 7, 8, &c. By which every angle being cut off, the body will then contain ſix geometrical ſquares, and eight hexagons. If you make *a c* the baſe, the point *f* of the other face ſhall be the vertex to cut out the triangle *a c f*, and *f h* ſhall be the baſe and *l* the vertex to cut out the triangle *f h l*, and *l n*, the baſe, and *c* the vertex to cut out the triangle *l n c*, and the like of all others, till every one be cut off, and the remaining ſolid will be a body containing 20 faces, each an equilateral triangle, called an icoſaedron.

Icoſaedron.

☞ This body may be cut by the aforeſaid lines of the dodecaedron, by drawing the parallel lines upon the cube at the diſtance of the leſſer ſegment inſtead of the greater.

10. Suppoſe a parallelopipedon be as follows, *viz* the length to the breadth as 1 is to the root of $\frac{1}{2}$, ſo ſhall D C or P B be equal 10,$\underline{0000}$ and B A or P G, to 7,$\underline{0710}$ Biſſect the lines G H, P B, and D C, in the points E L H, as alſo their oppoſites, and draw the right lines H B, H P, I G, I A, I D, I C, E B, E P, and their oppoſites; draw the diagonals D G, and F P, and their oppoſites, meeting the aforeſaid lines of every angle, and thereby conſtitute triangles, ſuch as D I G, &c. Laſtly cut away the angle P, by the triangle D I G, and the like of others, and thereby, at eight ſuch operations, will be left a ſolid body, containing 12 faces, each a rhombus, called the body of 12 rhombs.

Fig. XIII.

12 *Rhombs.*

11. Divide every ſide of a cube by extream and mean proportion, as the ſides *a d*, *d g*, *g k*, and *k a*; in the points *b*, *c*, *e*, *f*, *h*, *i*, *l*, *n*, where each ſide is equal to 10$\underline{0000}$, and the leſſer ſegments *a b*, *c d*, *d e*, *f g*, *g h*, *i k*, *k l*. and *n a*, each equal to 3$\underline{8100}$.

Fig. XIV.

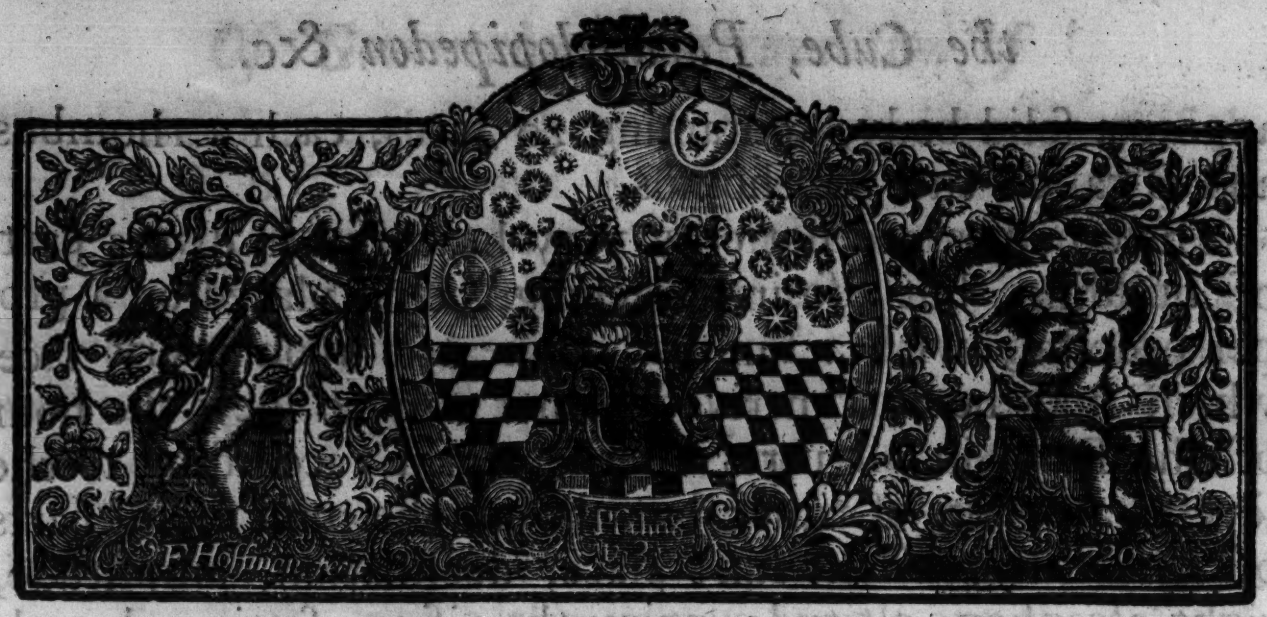
Draw right lines from the terms of the leſſer ſegments, on the one ſide, to the greater on the other ſide, as the lines *n c*, *l d*, *e k*, and *f i*, which will be parallel to each other. Alſo interſect them with the like parallels, as *b e*, *a f*, *n g*, *l h*, and draw the right lines *c g*, *b k*, *h d*, *i a*. Divide every face of the cube in the ſame manner, and then will the cube be prepared for the operation. About every ſolid angle of the cube are three triangles, as the triangles 1, 2, and 3, about the angle *a*, and the triangles 4, 5, 6, about the angle *d*, &c. Therefore every angle muſt be cut three times, always obſerving to continue each line, as a part is cut away; otherwiſe 'twill be a confuſed work; and thereby at 24 ſuch operations, will

30 *Rhombs.*

appear a ſolid body, containing 30 faces, each a rhombus, and is called the 30 rhombs.

Theſe bodies are not only very beautiful in divers parts of building, but alſo in gardening, being placed on a proper pedeſtal, with a ſun-dial delineated upon every face, which may be ſo contrived as not only to ſhew the hour of the Day, in all parts of the world, according to the ſeveral accounts of time; but alſo all the moſt uſeful parts of aſtronomy, as the ſun's place, declination, amplitude, right aſcenſion, altitude, azimuth, riſing, ſetting, length of day and night, beginning and ending of twilight, æquation of time, &c.

PART



THE

PRACTICE

OF

Architecture, Gardening, Menſuration, and *Land-Surveying,* Geometrically demonſtrated.

PART II.

I. *The Geometrical Conſtruction of the Tuſcan, Dorick, Jonick, Corinthian Compoſita, French and Spaniſh orders of Architecture, according to any proportions aſſigned, as alſo of all kinds of plans and uprights whatſoever.*

II. *The Geometrical and Trigonometrical Conſtruction of all ſorts of Plans, or Draughts of Gardens, Wilderneſſes, Labyrinths, Groves,* &c. *and Maps of Cities, Towns, Pariſhes, Lordſhips, Eſtates, Farms,* &c.

SECT. I.

Of the Geometrical Conſtruction of Plans and Uprights.

PLATE. V.

TO delineate the geometrical plain, or ichnography of a building is to accurately deſcribe a geometrical figure of the ſeveral parts thereof in true proportion.

The

The common meaſure uſed herein is the engliſh foot, divided into 12 equal parts, called inches, each being equal to the length of 3 barley corns placed in a right line, therefore, an engliſh foot is equal to the length of 36 barley corns. The inches graduated on a foot, or two foot rule, are ſubdivided in 4, 8, 10, 12, &c. equal parts, according to the pleaſure of the architect, &c.

The length, breadth, depth, &c. of any building, (or its parts) are called its dimenſions, and the meaſuring of thoſe dimenſions, is called taking the dimenſions.

All dimenſions, or meaſures of feet and inches, when taken, are thus written and expreſſed, *viz.* a dimenſion, whoſe length is ſix feet and ten inches, is written 06 *f.* 10 *i.* and ſixty two feet, and five inches, thus 62 *f.* 5 *i.* alſo if a dimenſion be fourteen feet and eleven inches in length, by nine feet ſeven inches in breadth, and two feet ten inches in depth, or thickneſs, 'tis thus written.

f.	*i.*	
14 :	11.	L)
09 :	07.	B} &c.
02 :	10.	D)

To expreſs one, two, three, &c. feet by a plain ſcale (or ſcale of equal parts); every ſuch equal part (as an inch, &c.) doth repreſent a foot, and two inches, two feet, &c. and if the inches are divided into 12 equal parts, each of thoſe parts will repreſent an inch. Therefore ſix feet and ten inches, is repreſented by ſix inches and $\frac{10}{12}$, and ſixty two feet five inches, by 62 inches 5 parts. And what is here ſaid of the diviſion of an inch into 12 equal parts (for the repreſentation of inches) the ſame is to be underſtood in the diviſion of any other length, as $\frac{1}{3}$, $\frac{1}{4}$, $\frac{1}{2}$, $\frac{3}{4}$, &c. of an inch, foot, yard, &c.

When the dimenſions of a building are taken in foot meaſure only (without regard had to inches, which in ſome works is very common) then any equal diviſion, as is moſt convenient, may repreſent one foot, as $\frac{1}{12}$ of an inch, which before repreſented but one inch, may now repreſent one foot, and conſequently an inch 12 feet; and the like of any other equal part, or diviſion whatſoever. And for the better information hereof, that the young ſtudent may have a perfect clear idea, I will here demonſtrate the conſtruction of ſuch plain ſcales, as is moſt convenient for his purpoſe.

Problem I.

To make divers ſcales of equal parts, as ſhall repreſent feet and inches.

1. Draw the right line D B, and at B erect the perpendicular B A, and make B A equal to B D.

2. Divide D B into 12 equal parts, at the points 1 2 3 4, &c. And alſo A B at the points 1 2 3 4, &c.

3. Draw, or continue B D to ſuch a length as you would have the ſcale to contain; as to E, and draw A A parallel, and equal in length thereunto.

Fig. I.

4. Draw A E, and divide it into 12 equal parts, at the points 1 2 3 4, &c.

5. Draw the lines 1, 1. 2, 2. 3, 3. 4, 4, &c. parallel to A A and E B.

6. From the point A to D, draw the right lines A D, A 1, A 2, A 3, A 4, A 5, A 6, A 7, A 8, A 9, A 10, A 11, and the line A B is the 12 diviſion.

The 12 centeral lines thus drawn, do divide the ends of the 12 parallels, each into 12 equal parts; therefore each of thoſe lines, ſo divided, doth repreſent one foot divided into 12 inches, as Z 1, and if you take the diſtance Z 1 in your compaſſes, and ſet that diſtance from Z to F, and from F to G, and from G to H, &c. each of thoſe diviſions ſhall be a foot, and equal to Z 1, the foot divided in 12 parts. And to take off with your compaſſes any number of feet and inches required, proceed as follows,

Let it be required to take off four foot eleven inches.

Practice.

Fig. I. Set one point of your compaſſes in the point 4 I, and extend the other on the ſame line, to the point of interſection of the centeral line A 11, and the line 1, 1, from which you take the meaſure, and that length ſhall truly repreſent four foot and eleven inches, according to the diviſion of that line. And what is here ſaid in reſpect to the diviſion of this line, the ſame is alſo to be underſtood of all others. And from hence it appears, that therein there

there is contain'd 12 various ſcales, and each repreſenting feet and inches, which is what was required to be done. The conſtruction of the ſcales of foot meaſure fig. II. are made by the very ſame rule, only the ſides K L and L M, are divided into 10 equal parts each, inſtead of into 12, as in fig. I. Fig. II.

I ſhall now proceed to the conſtruction of one other uſeful ſcale, which is called a ſcale, or line of chords, and is of as great uſe in meaſuring the angles of a building, as the other in meaſuring the ſides, &c.

Problem II.

To make a line (or ſcale) of chords, to any aſſign'd length.

Definitions.

A chord, or ſubtenſe, is a right line joining the extremity of an arch; ſo A C is the chord of the arch A M C.

A line of chords is no other than 90 degrees of the arch of any circle, transferr'd from the limb of a circle to a right line.

Every circle (great or ſmall, ſee problem III. part I. ſect. I.) is divided into 360 equal parts, term'd degrees, and conſequently a ſemicircle into 180, and a quadrant into 90. The ſemidiameter of a circle, or the ſide of a quadrant, is always called the radius, and is ever, in all circles, equal to 60 degrees of the ſame; therefore when the word radius is hereafter mention'd, then ſixty degrees is to be underſtood alſo. Fig. III.

Conſtruction.

2. Deſcribe the ſemicircle B M D O, and on O erect the perpendicular O M, which will divide the ſemicircle into two quadrants.

2. By problem XXX. part I. ſect. I. divide the arch M C D into 90 equal parts or degrees.

3. On the point D ſet one foot of your compaſſes, and extend the other to 10, and deſcribe the arch 10, 10, then open them to 20, and on the ſame point D deſcribe the arch 20, 20, and in the ſame manner the arches 30, Fig. III.

30, 40, 40, 50, 50, 60, 60, 70, 70, 80, 80, and 90, 90, which ſeveral arches will interſect the diameter B D, in the points 90, 70, 60, 50, 40, 30, 20, and 10, and divide it into unequal parts. This line, thus divided, is the line of chords, divided to every tenth degree, and by the ſame rule you may divide it to every degree, and therefore needs no further explication. And as the only uſe of this line is to meaſure the quantity of any angle, therefore 'twill not be improper, firſt to demonſtrate the variety of angles.

Demonſtration.

Fig. IV. When two right lines, as E F and F G, join each other, in a right lined poſition, they then make no angle, but do conſtitute a right line equal to both their lengths; ſo the line E F and F G, meeting together in a right line poſition, at the point F, do conſtitute the right line F G. But when two right lines meet, and not in a right lined poſition, as the right lines A D, and H D, (or A D and B D, or H D and D C) ſuch lines, by ſuch meeting, form an angle. The meeting of ſuch lines may happen in three ſeveral poſitions.

1. Two right lines may meet as the right line B D on the line A C, in the point D, making the diſtance from B to A, equal to B C, *viz.* the line B D, perpendicular to the line A C, and thereby conſtitute two equal angles, each containing a quadrant or arch of 90 degrees, and are called by the name of right angles. Therefore whenever a right angle is mention'd, an angle of 90 degrees is to be underſtood.

2. Two right lines may meet as the right lines A D and H D, and thereby conſtitute an angle, leſs than 90, and therefore is called an acute angle.

3. Two right lines may meet, at the right lines H D and D C, and thereby conſtitute an angle, more than 90 degrees, and therefore is called an obtuſe angle, and the ſum of all is, that an angle is either acute, right, or obtuſe.

An acute angle is that whoſe meaſure is leſs than a quadrant, or arch of 90 degrees.

A right angle is that whoſe meaſure is a quadrant, or arch of 90 degrees. And,

An obtuſe angle is that whoſe meaſure is more than a quadrant, or arch of 90 degrees.

Fig. IV. The meaſure of an angle is an arch of a circle, deſcribed upon the angular point, intercepted between the two ſides,

as

as containeth the angle, (an angle is always expreſſed by three letters, whereof the middle letter always denotes the angular point, as for example, if you expreſs the angle Z X Y, the letter X ſignifies the angular point, and the like of all other angles, in general).

The complement of an angle, (or arch) is ſo much of an arch, as the arch that meaſures the angle wanteth of a quadrant or arch of ninety degrees. So if an angle containeth 60 deg. the complement to an arch of 90 deg. or quadrant is 30 deg. and the like of any other angle.

All angles concurring upon one right line in a center, being taken together, are equal to a ſemicircle, or 180 degrees. Fig. V.

So the angles of the right lines *a a a*, &c. meeting at the point C, are (taken together) equal to a ſemicircle or 180 degrees.

Having thus ſhewn the conſtruction of plain ſcales, ſcales of chords, &c. and the nature of angles, I ſhall now proceed to apply them to practice, in the delineating of plans in general.

Problem III.

To make a plan equal to a plan given.

Let it be required to make the plan X Y, equal to the given plan T V.

1. By problem VII. part I. ſect. I. having firſt drawn the line 1, 2, and made the ſame equal to A B, make the angle 2, 1, 3, equal to the angle B A C. Fig. VI.

2. Make the line 1, 3, equal to A C, and make the angle 1, 3, 4, equal to the angle A C D.

3. Make 3, 4, equal to C D, and make the angle 3, 4, 5, equal to C D E.

4. Make 4, 5, equal to D E, and make the angle 4, 5, 6, equal to D E F, and by the ſame rule paſs through the whole, and thereby you will complete the plan X Y, which will be equal to the given plan T V.

Problem IV.

A ſecond example.

Let it be required to make the plan Y Z, equal to the given plan W X.

1. Make the parallelogram 1, 2, 9, 10, equal to A B L M, and draw the diameters 23, 23, and 21, 22.

2. Make 1, 3, 3, 4, 7, 9, and 8, 10, equal to A G, B H, I L, and K M.

3. Make 1, 19, and 20, 2, equal to A E and F B.

4. Continue the longeſt diameter infinitely, and make 23, 16, equal to W T, and by problem XI. ſect. I. part I. deſcribe the arch 19, 16, 20.

Fig. VII. 5. Make 21, 5, and 22, 6, equal to O R and O S, and, by the aforeſaid problem, deſcribe the arches 3, 5, 7, and 4, 6, 8.

6. Continue the end 9, 10, and make 11, 9, and 10, 12, equal to N L and M O.

7. Make the parallelogram 11, 12, 13, 14, equal to N O P Q, and make 13, 17, and 18, 14, equal to P C and D Q.

8. Continue 23, 23, infinitely towards 15, and make 23, 15, equal to W, V.

9. By problem XI. part I. deſcribe the arch 17, 15, 18, and 'twill complete the plan as required.

N. B. If any plan has a thickneſs, as the walls of a building, &c. that thickneſs (be what it will) muſt be drawn parallel to the external figure, in ſuch proportion as the thickneſs is found.

Problem V.

To meaſure (or take) the quantity of an angle by the help of a two foot rule, five foot, or ten foot rod only.

Let C A B be the angle of a building, and 'tis required
Fig. VIII. to draw upon paper an angle equal thereunto.

1. From A towards B, meaſure, or ſet off, any number of feet (as for inſtance in this example five foot) and alſo from A towards C, at the points 5 and 5.

2. Meaſure the diſtance between 5 and 5, and note it down on paper.

3. To draw the ſame upon paper, firſt draw a line at pleaſure, as D E, and from any ſcale of equal parts take off five parts, repreſenting the five foot ſet off from A,

the angle aforeſaid. With this diſtance ſet one foot on D, and with the other deſcribe the arch *o*, *o*. Take ten foot in your compaſſes (the diſtance between 5 and 5) and ſet one foot in *o*, and with the other interſect the arch *o*, *o*, in the point P, through which, from D, draw the right line D P N; ſo ſhall the right lines D E and D N, form the angle NDE, which ſhall be equal to the angle C AB, as required. And what is here ſaid concerning the taking off this angle, the ſame rule is alſo to be underſtood of all other angles in general, be they acute, right, or obtuſe. Fig. VIII.

Problem VI.

How to take the plan of a crooked line, or wall, which is not any part of an ellipſis or circle.

Let it be required to deſcribe the plan of the crooked line A B C.

Practice.

1. On a piece of paper deſcribe a crooked line, as near like the crooked line A B C as you can, and draw the ſtreight line A C; this being done, meaſure two foot (or more according to the nature of the curve) from C in a right line towards A, as from C to 2.

2. Meaſure from 2 to the crooked line, as to *e*, and on your paper, or eye-draught, make a mark repreſenting the point 2, and from thence draw a line to the curve, to repreſent the offset 2 *e*, and thereon ſet down the meaſure of the offset 2 *e*.

3. At a proper diſtance from 2, as at 4, take another offset, and ſignify the ſame in your eye-draught with the true meaſure of the ſame; as alſo its diſtance from C, and in the ſame manner proceed, making as many offsets as the turn of the curve requires, 'till you have taken the whole down. This being done you may deſcribe the ſame on paper, truly thus: Fig. IX.

1. Draw the line A C, by a ſcale of equal parts, equal in length to A C.

2. Set from C to 2, the diſtance meaſured, and on 2 erect the perpendicular 2 *e*, and thereon ſet off the length of that offset, as ſpecify'd in your eye-draught.

3. Set

3. Set the diſtance C 4, and on 4 erect the perpendicular 4 *f*, and thereon ſet off the length of that offset as meaſured. And in the like manner lay down the diſtance of every offset from one another, and their proper lengths, and then you have the ends of all your offsets, through which you may exactly trace the crooked line, as required.

Note, That the greater the number of offsets are taken, the more exact the curve may be drawn.

Problem VII.

How to take the plan of any building whatſoever.

The firſt ſtep to this performance, is to make an eye-draught of the ſame, *viz.* a rough draught drawn by hand only, expreſſing every wall, partition, room, door, chimney, window, &c. and the larger theſe kinds of draughts are made, the better 'tis for you, by reaſon you have good room to ſet down every dimenſion, which in a ſmall draught cannot be done.

Let it be required to make a plan of E F G H, which is ſuppoſed to be a real houſe.

Practice.

1. Make your eye-draught thereof as A B C D, and therein repreſent every door, window, paſſage, ſtair-caſe, partition, thickneſs of walls, rooms, &c.

2. With your five foot, or ten foot rod, meaſure the length and depth withoutſide, and note thoſe meaſures down to each reſpective ſide, or length.

3. Meaſure the thickneſs of thoſe outſide walls, and note them down alſo.

Fig. X. 4. By problem XXXII. ſect. I. part I. examine every angle, whether they be ſquare or not. If they are found to be ſquare, note it down, and if not ſquare, as acute, or obtuſe, then meaſure the quantity of one by problem V. hereof, and thereby, with the length of the four ſides given, you may, when you come to draw the plan of the ſame, by problem XIX. ſect. I. part I. delineate the ſame exactly.

5. Meaſure the exact breadth of every door and window withoutſide, and alſo the peers of brickwork between them, and ſet thoſe meaſures down to each reſpective part. The outſide walls being thus meaſured, the next proceeding to be made is in the diſtribution of the parts of the houſe; therefore walk over the ſame, and as you walk draw every particular room, with its chimney, doors, &c. as near the truth as may be, as alſo every ſtair-caſe, paſſage, cloſet, &c. which being finiſhed, your eye-draught is now fitly prepared to receive every dimenſion that is to be taken. To which proceed, *firſt*, as 'tis beſt to begin in a corner room. Therefore make a begining at I, where you Fig. X. muſt meaſure the exact length of every part thereof, as alſo the thickneſs of its party walls, or partitions, and note each meaſure down ſeverally in its reſpective place, and then proceed to K, and there perform the ſame, as alſo at L, MM, N, O, P, Q, &c. and thereby you'll have taken the juſt dimenſion of every part contain'd on that floor. And in the very ſame manner, may you take the plan of the cellars and other lower offices, or chambers, when required.

Your eye-draught being thus finiſhed, the next work is to delineate a true draught thereof from thoſe meaſures taken, which thus perform.

1. By the meaſures taken, it appears the houſe is a parallelogram 60 foot in front, and 40 foot in depth; therefore, with your ſcale of equal parts, deſcribe a Parallelogram, whoſe longeſt ſides are each equal to 60 parts, and the ſhorteſt to 40 parts.

2. The thickneſs of the outſide walls are found to be three bricks in thickneſs, which is equal to two foot and three inches, therefore, at the diſtance of two foot and Fig. X. three inches, of your ſcale, draw the interiour line, parallel to the exteriour, and thoſe two parallel lines do repreſent the thickneſs of the outſide walls.

3. By the meaſures of the eye-draught the diſtance from the angles to either of the adjacent windows is four foot, as alſo every window and peer of brickwork between. Therefore, divide the external lines A B, B D, A C and C D, in ſuch proportion, as the eye-draught doth exhibit, as alſo the internal line likewiſe, and thereby every window and out doors are truly divided in their proper places.

4. Draw the diameters O K and M M, and on each ſide the diameter OK ſet of ½ the breadth of the halls O and K, *viz.* 8 foot 10 inches, and draw on each ſide the lines V V and V V, and alſo the thickneſs of thoſe walls, as they are found to contain.

5. On each ſide the diameter M M ſet off two foot the ½ breadth of the entrance, and draw the parallel lines X X and X X, which will divide the parts N L and P I, into four equal parts.

6. Draw the thickneſs of the lines X X and X X, as they are found to contain.

7. Give to the door of every room, as Z Z Z Z Z, its proper breadth, and from thence ſet off the ſide of each
Fig. X. room towards the chimney, and draw the front of every chimney, as alſo ſet off the jaumes and chimney likewiſe, according to every reſpective meaſure of your eye-draught.

Laſtly, Divide the two ſtair-caſes according to each reſpective meaſure, and the plan will be completed, as required.

N. B. That the ſpace contain'd between any two parallel lines, that repreſents the thickneſs of a wall, muſt always be fill'd up with Indian ink, &c. that thereby the ſame may be underſtood to be a ſolid, as likewiſe the baſis of columns, as *y y y y* and *y*, &c. and thoſe parts that repreſent a door, or window, to be left clear without any filling up. See fig. X.

☞ I do adviſe the young practitioner to conſider this problem well, and to practice herein for ſome time, before he proceeds any further, that he may be perfect, which may be done by a few days practice.

This problem of taking the plans of houſes, is one of the moſt uſeful in architecture, and the eaſieſt to be acquired; therefore conſider the reaſons of the ſame judiciouſly before you proceed to problem VIII.

PROBLEM

Problem VIII.

How to draw the geometrical upright (or front) of any building.

Let it be required to draw a geometrical upright of the houſe A C B D, which is an elevation raiſed from the plan E F G H, fig. X. Fig. XI.

1. Make your eye-draught X, and then repair to the building, and meaſure the whole front from B to D, which being juſt 60 feet, write down the ſame at the bottom of your eye-draught.

2. Meaſure the whole height from the ground at B to A, which being juſt 37 feet, write down the ſame on your eye-draught againſt the middle of the height.

3. Meaſure the diſtance from B to *o*, from *o* to *p*, from *p* to *q*, from *q* to *u*, from *u* to *r*, from *r* to *s*, from *s* to *u*, from *u* to *w*, from *w* to *x*, from *x* to *y*, from *y* to *z*, from *z* to *z a*, from *z a* to *z b*, and from *z b* to D; and write down the ſeveral meaſures in each reſpective place.

4. Meaſure the diſtance from G to *h*, from *h* to *i*, from *i* to *k*, from *k* to *l*, from *l* to *m*, from *m* to *n*, and from *n* to A, and write down the ſeveral dimenſions, or meaſures, in their reſpective places, as may be ſeen in the eye-draught.

The meaſures, or dimenſions, being thus taken, and noted in your eye-draught, proceed to the delineation thereof as follows.

1. Make the parallelogram A C B D, in ſuch proportion that A C and B D, do contain 60 feet of any plain ſcale, and the ſides A B and C D 37 feet, as noted in the eye-draught.

2. On the lines B D and A C, ſet off the ſeveral meaſures *h*, *o*, *p*, *q*, *u*, *r*, *s*, *t*, *u*, *w*, *x*, *y*, *z*, *z a* and *z b*.

3. Draw the lines *o o*, *p p*, *q q*, *u u*, *r r*, *s s*, *t t*, *u u*, *w w*, *x x*, *y y*, *z z*, *z a z a* and *z b z b*.

4. On the lines B A and D C, ſet off the ſeveral meaſures 3, 4, 8, 4, 8, 4, 6, at the points *h*, *i*, *k*, *l*, *m*, *n*, E, and draw the lines *h h*, *i i*, *k k*, *l l*, *m m* and *n n*, which will interſect the former, and truly form every window, door, &c. contained therein, and thereby complete the geometrical upright as required.

PROBLEM IX.

PLATE VI.

To delineate the geometrical upright of any of the five orders of architecture (contained in any ſtructure) according to any proportion aſſigned.

For Example,

Let it be required to delineate the geometrical upright of the attick baſe, with the dorick capital, architrave, freize and cornish.

The meaſuring rod, with which the ſeveral parts of a column and its entablature are meaſured, is the diameter of the column divided into 60 equal parts, called minutes. Every architect divides the members, or parts of his orders, in ſuch proportion as he thinks moſt agreeable, as may be ſeen in the laſt folding pages hereof, wherein are exhibited, not only the geometrical profiles and ſections of the moſt noble antient orders of the *Romans*, but alſo of *Vitruvius*, *Palladio*, *Scamozzi*, *Serlio*, *Vignola*, *D. Barbaro*, *Cataneo*, *L. B. Alberti*, *Viola*, *Bullant*, *P. De Lorme*, *Perrault*, *Le Clerc*, *A. Boſſe* and *Michael Angelo*; which I thought fit to ſubjoin to this work, in ſuch a manner, as for the young ſtudent to behold, at one view, the great variety contained among them, as well as to make choice of ſuch as might beſt ſuit his purpoſe.

The diviſion of each member is a line, and the diſtance between any two of thoſe lines is called the height of the member, as the diſtance between the right lines A A and B 40, *viz.* the line A B, or A 40.

The projecture of every member is that length contained between the centeral line of the column and the termination thereof: the entablature of any order is the architrave, freize, and corniſh taken together.

Operation.

Fig. XVI. 1. Let X X be equal to the diameter of a given column, divided into 60 equal parts or minutes, by the help of which we'll deſcribe the attick baſe, as required.

And

And as 'tis uſual for all architects to prefix to every member its exact height and projecture as in the ſeveral figures XVI, XVII and XVIII, therefore draw the right line A B, and make it equal to 40 min. (as there written).

2. On A, erect the perpendicular A D, and let it repreſent the centeral line of the column continued through the baſe; alſo erect the perpendicular A 40, and continue it infinitely.

3. Becauſe the height of A B and A 40 is 10 min. therefore ſet off 10 min. from A to B, and from A to 40, and draw the line B 40.

4. The height of the next member B *c*, is 7 min. $\frac{1}{2}$; therefore ſet off 7 min. $\frac{1}{2}$ from B to *c*, and draw *c* K parallel to B 40.

5. The next member C E is 1 min. $\frac{1}{4}$ in height; therefore ſet off from *c* to E one min. $\frac{1}{4}$, and draw the line E L infinitely, and parallel to C K.

6. Becauſe the lines C K and E L, are each 36 min. $\frac{1}{3}$ in length; therefore ſet off 36 min. $\frac{1}{3}$ from C to K, and from E to L, and draw the line L K.

7. Continue L K to M, and divide K M into two equal parts at N, and thereon deſcribe the arch M P K.

8. The next member E F, is 4 min. $\frac{1}{2}$ in height; therefore ſet off 4 min. $\frac{1}{2}$ from E to F, and draw the line F *n*, infinitely.

9. The next member F G is 1 min. $\frac{1}{4}$ high; therefore ſet off 1 min. $\frac{1}{4}$, and draw the line G *o*, infinitely, and parallel to all the former.

10. Becauſe the lines F *n*, and G *o*, are each 35 min. in length; therefore ſet off 35 min. from F to *n*, and from G to *o*, and draw the line *n o*.

11. Draw the line *n* L, and divide it into two equal parts in *m*, and thereon, with the diſtance *m n*, deſcribe the arch *n* Q L.

12. The next member G H is five min. $\frac{1}{2}$ high; therefore ſet up 5 min. $\frac{1}{2}$ from G to H, and draw the line H *q* parallel to G *o*, and extend it infinitely.

13. The next and laſt member is one min. $\frac{1}{4}$ in height, therefore ſet up one min. $\frac{1}{4}$ from H to I, and draw the line I *r* parallel to the former, and extend it infinitely alſo.

14. Becauſe the lines H *q* and I *r*, are each equal to 33 min. $\frac{1}{2}$; therefore make H *q* and I *r*, each equal to 33 min. $\frac{1}{2}$, and draw the line *q r*. Fig. XVI.

15. Draw the line *q o*, and divide it into two equal parts at P, and thereon, with the diſtance P *o*, deſcribe the arch *o*, R, *q*.

16. Make H S equal to 30 min. and on the point S erect the perpendicular S *t*, and make S *t* equal to twice S *q*.

17. Draw the right line *t r*, and on *r*, with the diſtance *r t*, deſcribe the arch *t u*, and with the ſame opening on *t*, the arch *r u*, interſecting the former in *u*.

18. On the point *u*, deſcribe the curve *r t*, and 'twill complete one half of the attick baſe and baſe of the ſhaft, as required.

Dorick Capital.

2. *Let it be required to delineate the getmetrical upright of the dorick capital*, fig. XVII.

1. Draw the right line A *a*, infinitely, and at A erect the perpendicular A I, for the centeral line of the capital.

2. At 1 min. $\frac{1}{2}$ diſtance from A *a*, draw the line B *b* parallel to A *a*, and make A *a* and B *b* each equal to 28 min. and draw the line *a b*.

3. At 3 min. $\frac{1}{2}$ diſtance from B *b*, draw the line C *d* infinitely, and parallel to B *b*.

4. Continue *a b* to *e*, and divide *b e* into two equal parts in the point *c*, and thereon, with the diſtance *c b*, deſcribe the ſemicircle *b* 30, *e*.

5. Set up 9 min. from C to D, and draw the line D *f*, infinitely.

6. Take 26 min. in your compaſſes, and ſet that diſtance from C to *d*, and from D to *f*, and draw the line *d f*.

7. Set up 3 min. $\frac{1}{3}$ from D to E, and draw E L infinitely.

8. Divide E D into three equal parts at the points *a a*, and draw the line *a g* and *a h*, infinitely.

9. Set 30 min. from E to *k*, and continue *d f* to L, and divide L *k* into three equal parts at the points *m* and *n*, from which draw lines parallel to *f* L, and they ſhall terminate the lines *f g h i*.

10. Set up 6 min. and $\frac{1}{2}$ from E to F, and draw the line F *n* infinitely, and parallel to the line E L.

11. Make F *n* equal to 36 min. and draw the line K *n*, which divide into 5 equal parts, and on the points K and *n*, with an opening of 4 of thoſe diviſions, deſcribe the arches 2 2 and 4 4, interſecting each other in the point *m*, whereon, with the radius *m* K, deſcribe the arch K *n*.

12. Set up 6 min. $\frac{3}{4}$ from F to G, and draw the line G *o*, infinitely, and parallel to the line F *n*, and at *n* erect the perpendicular *n o*, and make G *o* equal to 37 min.

13. Set

13. Set up 2 min. $\frac{2}{3}$ from G to H, and draw the line H *s* infinitely, and parallel to G *o*, and make H *s* equal to 39 min. as alſo the line I *t*, at the parallel diſtance of 1 min. $\frac{3}{4}$.

14. Fig. Z repreſents the face of the member H *s o* G, which deſcribe as follows, *viz.* draw the line *o* S, and biſſect it in R, and divide each half into 7 equal parts, and with the diſtance of 6 of thoſe parts, on the point *o*, deſcribe the arch 7 7; alſo with the ſame diſtance on R, deſcribe the arch 6 6, interſecting the former in the point 8, and alſo deſcribe the arch 5 5. This being done with the ſame opening on the point S, deſcribe the arch 3 3, interſecting the laſt in the point 9. Fig. XVII.

15. The points 8 and 9 are the centers of the arches O R and R S, which compoſe the face of the member, as required.

16. Fig. N repreſents the fillet B *b a* A (under the aſtragal C *d e b* B) with a ſection of the ſhaft, which deſcribe as follows, *viz.* biſſect *n* A in *i*, and make *n m* equal to three times *n i*, and draw the line A *m*, and on *m*, with the diſtance *m* A, deſcribe the arch A S, and on A the arch *m t*, interſecting the former in *r*, which is the center of the arch or hollow A *m*, as will complete the capital with the aſtragal as required.

3. *Let it be required to delineate the geometrical upright of the dorick, architrave, freize and cornice,* fig. XVIII. *Dorick, Architrave, Freize and Cornice.*

Practice.

1. Draw the line A *a*, at pleaſure, and at *a* erect the perpendicular *a*, *o*, which is to repreſent a continuation of the centeral line, from which every meaſure of projecture, and on which every meaſure of height is to be accounted.

2. At the parallel diſtance of 11 min. draw B *c* infinitely, and make *a* A and B *b*, each equal to 26 min. and draw the line A *b*.

3. At the parallel diſtance of 14 min. $\frac{1}{2}$, draw *c d* infinitely, and make B *c* and C *d*, each equal to 27 min. and draw the line *c d*.

4. At the parallel diſtance of 4 min. $\frac{1}{2}$ draw D *g f* infinitely, and make C *e* and D *f*, each equal to 30 min. and draw the line *e f*. Fig. XVIII.

5. At the parallel diſtance of 45 min. draw the line E *i* infinitely, and make D *g* and E *h*, each equal to 26 min. and draw the line *g h*.

6. At the parallel diſtance of 5 min. draw F *k l* infinitely, and make E *i* and F *k*, each equal to 27 min. and draw the line *i k*, alſo make F *l* equal to 30 min. $\frac{1}{2}$.

7. At the parallel diſtance of 5 min. draw G *n* infinitely, as alſo H *o*, and make G *n*, and H *o*, each equal to 35 min. $\frac{1}{2}$.

8. Draw the line *l n*, and divide it into 4 equal parts, and deſcribe the triangle *n m l*, making the ſides *n m* and *m l*, each equal to three parts of *l n*, and the point *m* is the center of the arch *n*, 2, *l*.

9. At the parallel diſtance of 6 min. draw I P *q r* infinitely, and make I *q* equal to 39 min. and $\frac{1}{2}$, and make I *r* equal to 64 min. $\frac{1}{2}$.

10. Draw the line *q o*, and with the diſtance *o q* on *o*, deſcribe the arch *q* P, and on *q* the arch *o* P, interſecting each other in the point P, which is the center of the arch *q*, 7, *o*.

11. At the parallel diſtance of 8 min. draw K S infinitely, and make K S equal to I *r*, and draw *r* S; alſo make S *t* equal to 1 min.

12. At the parallel diſtance of 3 min. $\frac{1}{4}$, draw L *x y* infinitely, as alſo M P, at the parallel diſtance of $\frac{3}{4}$ min. and make L *z* and M P, each equal to 68 min. and draw the line *z* P.

13. Draw the line *t y*, and divide it into two equal parts in *w*, and on *t*, with the diſtance *t w*, deſcribe the arch *w u*, and with the ſame diſtance on *w* deſcribe the arch *t u*, interſecting the former in *u* which is the center of the arch *t w*, and in the ſame manner on *x*, deſcribe the arch *w y*.

Fig. XVIII.

14. At the parallel diſtance of 6 min. $\frac{3}{4}$, draw N S infinitely, as alſo O T, at the parallel diſtance of 2 min. $\frac{1}{4}$, and make N S and O T, each equal to 76 min. and draw the line S T.

15. Draw the line P S, and divide it into two equal parts in V, and with the diſtance P V on P deſcribe the arch V Q, and with the ſame diſtance on V deſcribe the arch P Q, interſecting the former in Q, whereon, with the ſame diſtance, deſcribe the arch P V, and in the ſame manner on R, the arch V S alſo, which will complete the profile, or geometrical elevation of the architrave, freize and cornice, as required.

PROBLEM

Problem X.

To delineate the triglyphes of the dorick order.

This ornament is ſeldom uſed in any order beſides the dorick, and is always placed in the freize exactly over the column. The height of this ornament is always equal to the height of the freize wherein 'tis placed, (the capital excepted) and the breadth to half the diameter of the column at the baſe. In every triglyphe are 7 parts, *viz.* two entire glyphes or channels (as *z m*) meeting in an angle, two ſemi-glyphes, as *z i*, and three interſtices or ſpaces, as *z l*, &c. To delineate this ornament you muſt, Fig. XVIII.

1. Take 15 min. and place from D to Z, and from E to *b*, and draw *b* Z.

2. Divide D Z and E *b*, each into 6 equal parts, and draw the lines *a b*, *a b*, &c.

3. Set 2 min. from *b* to *x*, and from E to *z*, and draw the line *z x*.

4. On *x*, with the diſtance *x o*, deſcribe the quadrant *o n*, and with the ſame opening on *m* the ſemicircle *o n o*.

Hence it appears, that the triglyphe muſt be divided into 12 equal parts, of which two muſt be given to each entire channel, as well as to the ſpaces between, and one to each ſemi-channel, at the extreams.

5. Continue the lines *b* Z, *a b*, &c. through the liſt of the architrave towards *o o o*, &c. and draw the line *q q* parallel to C *e*, and *p p*.

6. Make the parallel diſtance of *p p*, equal to 1 min ½, and *q q* to 4 min.

Laſtly, if right lines be drawn from the points of interſection *r r*, &c. towards the points *c c c*, &c. (which are in the midſt of the liſt) till they meet the line *p p*, they will truly form the guttæ, or drops, and complete the whole, as required.

Theſe guttæ, or drops, are made either in ſhape of the fruſtumof a cone, or pyramis, and oftentimes exact cones or pyraments.

When triglyphs are placed throughout an entablature, the empty ſpaces between muſt be exactly ſquare (and are called metops). From whence it happens, that in many ſtructures the triglyphes are left out, on account they can-

not be ſo diſtributed, as to make the empty ſpaces, or metops, exactly ſquare. Theſe metops are oftentimes enriched with oxes ſculls, fruit, flowers, &c. according to the nature of the building wherein they are introduced.

Problem XI.

To deſcribe the upright and inverted cima, or cymaiſe, vulgarly called ogee.

I. Of the upright cima. Fig. A B.

Plate VII.

Practice.

1. Draw the right line *a m*, and biſſect it in *n*.
2. On *m*, with the diſtance *m n*, deſcribe the arch *n r*, and alſo on *n* the arches *m r* and *n o*.
3. With the ſame opening on *a*, deſcribe the arch *n o*.

Laſtly, The points *o* and *r*, are centers whereon you may deſcribe the arches *m t n* and *n i a*, which will complete the upright cima, as required.

II. Of the inverted cima. Fig. A D.

Plate VII.

Practice.

1. Divide the projecture given to the cima, as *a b*, into 6 equal parts.
2. Make *m l* and *g i*, each equal to $\frac{1}{6}$ of *a b*, and draw the line *i m*.
3. Biſſect *i m* in *k*, and then deſcribe the cima, as in the preceding, and the inverted cima will be completed, as required.

Problem XII.

To delineate the geometrical upright of any pillaſter, or column, with its entablature.

1. Of

I. Of a pillaſter.

PLATE VII.

Practice.

1. Draw the line I H for the centeral line. Fig. I.

2. By the firſt of problem IX. hereof, delineate the baſe G.

3. Make K L equal to the aſſigned height of the pillaſter, *viz.* 7 diameters, &c. and through the point L draw B C parallel to E F, and make K F, K E, L C, L B, each equal to the ſemidiameter of the pillaſter, *viz.* 30 min.

4. Draw the right lines B E and C F, and then will the body of the pillaſter be completed.

5. By the ſecond of problem IX. hereof, delineate the capital A; and by the third, the architrave, freize and corniſh M D N, and then will the whole be completed, as required.

II. Of a column.

PLATE VII.

Practice.

1. Draw the centeral line A Q. Fig. II.

2. By the firſt of problem IX. hereof, delineate the baſe B.

3. Make C I equal to the aſſigned height of the ſhaft of the column, *viz.* 7 diameters, &c. and through the point I draw the right line L I K at right angles to the centeral line A Q.

4. Divide C I into 3 equal parts, and ſet up one from C to F, and through the point F draw the right line G F H.

5. Make C D, C E, F H and F G, each equal to the ſemidiameter of the column at the baſe, *viz.* 30 min. and draw the right lines D H, and E G, parallel to C F.

6. Make I K and I L, each equal to the ſemidiameter at the capital or head of the ſhaft, *viz.* 26 min. &c.

7. On

7. On F deſcribe the ſemicircle G *a a* H, and make the chord line *a a*, equal to L K and parallel to G H, and draw the right lines L *a* and K *a*.

8. Divide the arches *a* H and *a* G, into any number of equal parts (the more the better) ſuppoſe 4, as in the diagram at the points *n m o* G, &c. and draw the lines *n n*, *m m*, and *o*, *o*.

9. Divide F I into the ſame number of equal parts, as *a* G or *a* H, which in this example is 4, at the points 1, 2, 3, I, and through the points 1, 2 and 3, draw the right lines W 1 X, T 2 V and R 3 S, at right angles to the centeral line A Q.

10. Upon the points *n* and *n*, erect the perpendiculars *n* R, *n* S, or at the diſtance of 1 *n*, draw the lines *n* R and *n* S parallel to F I, and they will interſect the line R 3 S in the points R and S.

11. At the diſtance of 2 *m*, draw the parallels *m* T and *m* V, and they will interſect the line T 2 V in the points T V.

12. At the diſtance of 3 *o*, draw the parallels *o* W, and *o* X, and they will interſect the line W 1 X in the points W X.

Laſtly, lines being drawn from G to L, and from H to K, though the ſeveral points of interſection W T R, and S V X, ſhall truly form the diminſhing (or upper) part of the ſhaft, as required.

To which being added the capital and entablature, as before taught, the whole will be completed, as required.

N B. That in conſideration, as the upper part of the ſhaft of every column is ſo much leſſer than the upper part of a pillaſter, by ſo much as the diminution of the column is, as generally in the tuſcan $\frac{1}{4}$, the dorick $\frac{1}{5}$, the ionick $\frac{1}{6}$, the corinthian $\frac{1}{7}$, and the compoſita $\frac{1}{8}$, of their diameters at the baſe, therefore when you are to delineate any pillaſter, &c. with its entablature, from any of the geometrical elevations, at the end hereof, you muſt add to the projecture of every member, half the diminution of the column, and thereby every member will have its true projecture.

PROBLEM

Problem. XIII

To delineate the geometrical upright of any wreath'd, waved or twiſted columns.

Theſe kind of columns may be deſcribed divers ways, but none better than the following.

Plate VII.

Practice.

1. By the preceeding problem, delineate the corinthian ſhaft B O D N, and make B A equal to B D. Fig. III.
2. Draw the right line A D, and on the point A with any radius, deſcribe an arch as C Z, which divide into 12 equal parts at the points 1, 2, 3, 4, &c.
3. Lay a ruler from A to the ſeveral points 1, 2, 3, 4, 5, &c. and draw right lines to the ſide of the column D B, as to the points *n*, *n*, *n*, &c.
4. From the ſeveral points *n*, *n*, *n*, &c. draw the right lines *n m*, *n m*, *n m*, &c. parallel to the baſe D N.
5. On N, with the diſtance N *m*, deſcribe the arch *m i*, and with the ſame opening on *m*, deſcribe the arch N *i*, interſecting the former in the point *i*, which is the center of the arch N *m*.
6. Perform the ſame operation at the ſeveral diviſions, and thereby you will complete the ſhaft as required.

Plate VII.

Shewing how to perform the aforeſaid operation a different way from the foregoing. FIg. IV.

Practice.

1. By the preceeding problem, delineate the ionick ſhaft E R P Q, and make P E equal to one third of F P, and draw the right line F E.
2. With the diſtance E F, on E deſcribe the arch F V, and on F the arch E V, and alſo on V the arch E 1, 2, 3, 4, 5, 6, 7, 8, 9, 10, 11, F.

3. Divide the arch E 1, 2, 3, &c. F, into 12 equal parts, at the points 1, 2, 3, 4, 5, 6, 7, 8, 9, 10, 11, and from them draw right lines parallel to the baſe P Q, 'till they interſect the column in the points *n*, *n*, *n*, &c. and *o*, *o*, *o*, &c.

4. Divide each of the diviſions *n*, *n*, &c. and *o*, *o*, *o*, &c. as Q *o*, or P *n*, into 4 equal parts, and with the diſtance of 3 of thoſe parts, deſcribe the ſeveral arches therein on the points P, *n*, *n*, *n*, &c. and Q, *p*, *o*, *o*, &c. interſecting each other in *r*, *r*, *r*, &c. which points of interſection are the centers of the ſeveral arches that compoſe the column, and being deſcribed will complete the ſhaft, as required.

PLATE VII.

Shew the like operation in ſmall columns.

Practice.

Fig. V.

1. By the preceeding problem delineate the dorick ſhaft S T G I, and make I K and G H, each equal to G I, and draw H K, and the diagonals K G and H I, interſecting each other in *n*, whereon deſcribe the arch K I.

2. Make the triangle G *m* H, equal to the triangle I *n* K, and on *m* deſcribe the arch H G.

3. Make K M and H L equal to H K, and draw the line L M and the diagonals M H and L K, interſecting each other in *u*, the center of the arch H L.

4. Make the triangle K *w* M equal to K *u* M, and on *w* deſcribe the arch K M, and ſo on with all the others, and thereby the whole will be completed as required.

The ſhafts fig. VI, VII, and VIII. are the ſame ſhafts completed, whereby their effect may be adjudged.

PROBLEM XIV.

PLATE VIII.

How to divide the breadth of any pillaſter into its flutes and fillets, and to delineate the geometrical upright of the ſame.

1. The general received proportion for dividing the breadth of a pillaſter, is to divide every pillaſter into ſeven flutes and eight fillets, and that the breadth of e-

very fillet contain $\frac{1}{3}$ part of the breadth of a flute, and thereby the breadth of every pillaſter ſo fluted, is divided into 29 equal parts, *viz.* eight equal parts contained in the eight fillets, and twenty one equal parts in the ſeven flutes, each containing three, and thereby every fillet is equal to $\frac{1}{3}$ of a flute as aforeſaid. This being well underſtood, we'll now proceed to the geometrical conſtruction thereof. Fig. XIX.

PLATE VIII.

Let the line F G *be the given breadth of a pillaſter, to be divided into its flutes and fillets, as aforeſaid.*

1. Draw a line at pleaſure, as A B.

2. With any ſmall opening of the compaſſes, ſet off 29 times of that opening, beginning at any part thereof, as at B, and ending at A, as in the figure.

3. Having thus ſet off 29 equal parts on the line A B, the next work is to make an equilateral triangle there from, which thus perform.

On the point A, with the diſtance A B, deſcribe the arch B *a*, and with the ſame diſtance on B, deſcribe the arch A *a*, interſecting the former in the point C, and draw the lines A C and C D.

4. From the angle, or point C, draw right lines through all the 29 diviſions marked 1, 2, 3, &c. and continue them infinitely, and thus have you prepared in effect an inſtrument that will at once divide the breadth of any pillaſter that may be given, as ſhall appear by the example in hand.

5. Take the given line F G in your compaſſes, and ſet that diſtance from C to E, and from C to D, and draw the line D E; and becauſe the figure is equilateral, therefore D E is equal to the given line F G, and by the lines C *o*, C *o*, &c. drawn through the 29 diviſions, is divided into 29 equal parts alſo, which is the diviſion of the pillaſter required.

Operation.

1. Erect the perpendicular E H, which repreſents one ſide of the pillaſter.

2. The firſt fillet being equal to $\frac{1}{29}$ of D E, therefore at the diſtance E *b*, draw *b b* parallel to E H, and it ſhall be the firſt or outſide fillet.

3. As

3. As every flute is equal to three fillets, therefore number three equal parts from *b* to *c*, and draw *c c* parallel to *b b*, and it ſhall be the firſt or outſide flute.

Fig. XIX. 4. At the diſtance of one diviſion from *c* to *d*, draw *d d* for the next fillet, and alſo at the diſtance of three diviſions from *d* to *e* draw *e e* for the next flute, and in the ſame manner, taking one diviſion for a fillet and three for a flute, you will complete the flutes and fillets of the pillaſter, as required.

N B. The depth of every flute in the pillaſter is $\frac{1}{3}$ the breadth of the flute, therefore to deſcribe the circular termination, ſet up $\frac{1}{6}$ of the breadth of the flute from *x* to *z* and that will be the center of the curve that terminates the flute *c c*, and the like of all others.

☞ 'Tis to be obſerved (as I ſaid before) that in reſpect to the figure being equilateral, the breadth of any pillaſter may thereby moſt readily be divided, be the ſame but the tenth of an inch, or 1000 feet, &c. and therefore of univerſal uſe.

Fig. XIX. The line M N is the breadth of a ſmaller pillaſter, which is divided in the ſame proportion and by the very ſame rule, and is inſerted to ſhew the reaſon of the figure without any more words, to which I refer you.

Problem XV.

To divide the baſis, or plan of the ſhaft of a column into its 24 *flutes, and* 24 *fillets.*

The number of flutes were formerly limited to every order, the dorick being allowed 20, and the ionick 24. But that limitation has been diſpenſed with, with divers of our modern architects. In this example 'twill be ſufficient to divide a ſemicircle, or the ſemi-baſis of the ſhaft, inſtead of the whole, the laſt being but the firſt repeated.

Practice.

1. Let B D be the diameter of the baſis of a column given. Fig. XX.

2. Divide the ſame into two equal parts in A, and thereon, with the diſtance A B, deſcribe the ſemicircle B C D.

3. Divide the ſame into two quadrants by the perpendicular A C, and divide each quadrant into 12 equal parts, and draw the lines *a*, *a*, *a*, *a*, &c. through the ſame. And thus is the ſemi-baſis prepared for the deſcription of the flutes and fillets.

4. Divide any of the 12 parts (as B *z*) into eight equal parts.

5. Take three of thoſe eight equal parts in your compaſſes, and on thoſe points where the lines *a*, *a*, *a*, &c. interſect the ſemicircle B C D, deſcribe the ſeveral arches *i*, *i*, *i*, *i*, &c. which ſhall be the flutes, and intervals of the fillets, as required.

Problem XVI.

To divide the baſis, or plan of the ſhaft of a column, into its 24 flutes without fillets, as is uſual in the dorick order.

I ſhall here (as in the laſt) make uſe of the ſemi-baſis only. Fig. XX.

Practice.

1. Complete the ſemicircle B C D, and divide the ſame alſo into 12 equal parts, by the lines *n*, *n*, *n*, &c.

2. Divide any one of thoſe parts, into eight equal parts, as the part 1 and 2.

3. From the ſeveral points where the lines *n*, *n*, *n*, &c. interſect the ſemicircle, on thoſe ſeveral lines ſet off two of thoſe eight parts, as at the points *o*, *o*, *o*, *o*, &c. which are the centers of each flute. Therefore on thoſe points, with the diſtance *o* 1 or *o* 2, &c. deſcribe the ſeveral arches, and they will complete the flutes of the ſemi-baſis, as required. Fig. XX.

Problem XVII.

To deſcribe on a paper drawing, wall, &c. *the geometrical upright of a column, with its flutes and fillets.*

To deſcribe the geometrical upright of a column, is to ſhew in what manner the flutes and fillets diminiſh in their breadth, as they approach the extream parts of the column.

Practice.

Fig. XX. If from the interſection of the flutes and fillets, you draw the lines *r*, *r*, *r*, *r*, &c. perpendicular to B D, and complete their terminations with circular lines, as in the figure, they will complete the geometrical upright of that part, as required, and every flute and fillet have its due breadth, according to the rules of perſpective.

Problem XVIII.

To deſcribe (*in the aforeſaid manner*) *the geometrical upright of a column, with its flutes only, as often uſed in the dorick order.*

Practice.

Fig. XX. 1. If from the interſection of the flutes in the ſemicircle B E D, you draw the lines *s*, *s*, *s*, &c. perpendicular to B A D, and complete their terminations with circular lines, as in the figure, they will complete that geometrical upright, as required.

Problem XIX.

To divide the baſe, or plan of the ſhaft of a column into its 20 *or* 24 *flutes, according to* Vitruvius.

Practice.

Fig. XXI. 1. On A deſcribe the baſe of the ſhaft, as the circle B *a b* D E.

2. Divide the circumference into 20 or 24 equal parts by the lines *n*, *r*, *r*, *r*, &c..

3. Make

3. Make *i a* and *i b*, each equal to $\frac{1}{2}$ *i m*, and draw the right line *a b*.

4. Complete the geometrical ſquare *a d c b*, and draw the diagonals *a c* and *d b*, interſecting each other in *n*, the center of the flute *a o b*.

5. On A, with the diſtance A *n*, deſcribe the circle *n r r r*, &c. interſecting the lines *r*, *r*, *r*, &c. which are the 24 centers of the 24 flutes, whereon, with the radius *n b* or *a n*, you may complete the whole, as required.

Problem XX.

To divide the baſe, or plan of the ſhaft of a column into its 20 *or* 24 *flutes, according to* Vignola.

Practice.

1. On E deſcribe the baſe of the ſhaft, as the circle A *d b* B D. Fig. XXII.

2. Divide the circumference into 20, or 24 equal parts by the lines *e*, *e*, *e*, &c.

3. Make *i b* and *i d*, each equal to $\frac{1}{2}$ *i h*, and draw the right line *d b*.

4. Complete the equilateral triangle *d a b*, and then will the angle *a* be the center of the flute *d n b*.

5. On E, with the diſtance E *a*, deſcribe the circle *e e e*, &c. interſecting the lines *e*, *e*, *e*, &c. in the points *e*, *e*, *e*, &c. which are the 24 centers of the 24 flutes, whereon, with the radius *a b* or *a d*, you may complete the whole, as required.

N. B. That although both the ſhafts in theſe examples are divided into 24 flutes, yet you are to underſtand that neither *Vitruvius* or *Vignola* made uſe of any more than twenty; therefore if you are willing to follow their rules therein exactly, you muſt divide the circumference of the ſhaft into 20 parts, inſtead of 24, and then proceed in all other reſpects, as in the preceding problems, and thereby you will complete the whole, as required.

Problem XXI.

To divide the baſe of the ſhaft of a column, into its cabled flutings.

Practice.

Fig. XXIII. 1. On A deſcribe the baſe of the ſhaft, as the circle *a a a*, &c.

2. By problem XV. hereof, delineate the flutes and fillets thereof.

3. On *o o o*, &c. with the radius *o, a, o, a,* &c. deſcribe the arch *r a s*, &c. and thereby you will deſcribe the cabled fluting, as required.

Problem XXII.

To divide the baſe of the ſhaft of a column into its 24 *flutes and* 24 *fillets, after the manner of the columns within the* Pantheon.

Practice.

Fig. XXIV. 1. Deſcribe a circle repreſenting the baſe of the ſhaft, and divide the circumference thereof into 24 equal parts by the lines *a, a, a,* &c.

2. Divide each part into 5 equal parts, of which give 4 to every flute, and one to each fillet.

3. Make the depth of each flute, equal to the breadth of every fillet, and then will the whole be completed, as required.

Fig. XXV. is the plan of the dorick ſhaft cut into cants inſtead of flutings withou any cavity, firſt taught and practiced by *Vitruvius*, which I here inſert, to ſhew the young ſtudent what a great variety there is contained in the form and manner of fluting columns.

Problem XXIII.

To deſcribe the ionick voluta according to the antique manner.

Plate IX.

Practice.

Fig. I. 1. Delineate the Abacus B A, and from the point 2 8 $\frac{1}{2}$, let fall the cathetus, perpendicular, and delineate the hollow of the voluta B B, the ovolo B D, the aſtragal B E, and the cincture or annulet B F.

2. Draw

2. Draw the right line F B ſo as to paſs through the middle of the aſtragal B E, interſecting the cathetus in the point 1 3.

3. On the point 1 3, with the diſtance 1 3 Y, deſcribe the circle or eye of the volute Y X Z, and draw the geometrical ſquare Y X T Z.

4. Biſſect Y X, X T T Z and Z Y in the points 1, 2, 3, 4, and draw the geometrical ſquare 1 2 3 4, and alſo the diagonals 1 3 and 2 4.

5. Divide each diagonal into 6 equal parts at the points 5, 9, 11, 7, 6, 10, 12, 8.

6. Make 1 *a* equal to $\frac{1}{8}$ of 1 2, as alſo 2 *c*, 3 *d*, 4 *h*, 5 *i*, 6 *n*, 7 *v*, 8 *k*, 9 *o*, 10 *m*, 11 *t*, 12 *s*, and thus will you have divided the eye of the volute into its proper centers, on which you may deſcribe it as follows, *viz.* on the point 1, with the opening 1, 2 $8\frac{1}{2}$, deſcribe the arch $28\frac{1}{2}$ B, and on the point *a* the arch *n m*, alſo on the point 2 the arch B C, and on *c* the arch *m w*; likewiſe on the point 3 the arch C F, and on *d* the arch *w* E, and ſo by removing to the other centers 4 *h*, &c. you will complete the whole voluta, in the moſt elegant manner as can be deſired. And that the young ſtudent may have a perfect idea of the centers thereof (which in number are 25) I have in fig. II. deſcribed the eye of the volute at large, wherein the numerical figures denote the centers of the exteriour line, and the ſmall italick letters the centers of the interiour, which in an inſtant will enable him to delineate the ſame with great eaſe and delight.

SECT. II.

Of the Derivation, Proportion, Diminution and Intercolumnation of the Tuſcan, Dorick, Ionick, Corinthian and Compoſite Orders of Architecture.

I. Of the Tuſcan order.

THE Tuſcan or ruſtick order (ſaith *Vitruvius*) is the moſt ſimple and ſtrongeſt of all the orders of architecture, it hath no ornaments and but few mouldings. This order was firſt made by the *Aſiatic Lydians*, who

are ſaid to be the firſt that inhabited *Italy*, and brought it into that part, called Tuſcana or Tuſcany, and from thence was called the *Tuſcan* order.

And altho' this order is of all others the moſt plain and ſimple, yet many noble ſtructures have been built therewith, as the ports and entrances into cities, amphitheatres, bridges, &c. and particularly that famous column of the *Trojans*, that of *Antoninus* at *Rome*, and likewiſe that of *Theodoſius* at *Conſtantinople*, which are all remaining to this day.

The proportion, diminution and intercolumnation of this rural order is as follows.

1. The ſhaft only without its baſe and capital is in length ſix diameters of the ſhaft's baſe, and the height of the baſe and capital each a ſemidiameter thereof.
2. The entablature of this order is ſeldom leſs than $\frac{1}{4}$ of the ſhaft's height.
3. The pedeſtal hath two diameters of the ſhaft's baſe for its height, and the ſhaft at the upper part diminiſhes $\frac{1}{4}$ of its diameter at the baſe.
4. The intercolumnation of this order may be made very large, by reaſon the architrave is generally made of wood, but the moſt uſual is about 4 diameters of the ſhaft at the baſe.

II. Of the Dorick order.

The Dorick order is of all others the moſt grave and maſculine, and the moſt agreeable to nature. *Scamozzi* calls it Herculean aſpect, in regard to its excellent proportion. This order had its original and name from the *Dorians*, a *Grecian* people of *Aſia*, or as ſome ſay, from *Dorus* King of *Achaſis*, who is ſaid to be the firſt that built at *Argos*, and dedicated a temple of this order to *Juno*.

The proportion, diminution and Intercolumnation of this noble order, is as follows.

1. The ſhaft, excluſive of the baſe and capital (when alone) is in length ſeven diameters, but when in porticos and mural work but ſix.
2. The height of the capital is a ſemidiameter of the ſhaft's baſe, as alſo the Attick baſe, &c. when uſed here-

in. For you muſt note, that this order was anciently made without any baſe, as may be ſeen by the geometrical profiles of the *Theatre* of *Marcellus*, the Bath of *Diocletian*, &c. at *Rome*, at the end hereof.

3. The entablature is generally two diameters in height, and is oftentimes enriched in the freize with triglyphes and metops. The ſhaft of this order is oftentimes fluted, with a ſhort edge without any fillets, as laid down by *Palladio* and *Vignola*, in the preceding problems of ſect. I. hereof. And as I ſaid before, that the ancients, never uſed any baſe to this order, ſo 'tis alſo to be underſtood of pedeſtals; therefore when any are uſed herein, *Palladio* allows their height to be two diameters, and $\frac{1}{3}$ of the ſhaft's baſe.

4. The diminution of the ſhaft is $\frac{1}{7}$ of the ſhaft's diameter at the baſe. And the intercolumnation of this order is three diameters, except at ſuch times when the diſtribution of the triglyphes and metops require ſomething more or leſs.

III. Of the Ionick order.

The Ionick order is an exact mean proportion, between the delicate and the robuſt. *Vitruvius* compares it to a matron decently dreſs'd. It was firſt invented, or introduced by *Ion*, in *Ionia*, a province in *Aſia*, and 'tis ſaid that the Temple of *Diana*, at *Epheſus*, was built of this order.

The proportion, diminution, and intercolumnation of this decent feminine order, is as follows.

1. The ſhaft with its baſe and capital, were anciently but 8 diameters, which by the moderns was thought too little, and therefore to give it proper ſtature, they added one diameter, ſo that it now contains 9 diameters in height. The ſhaft is fluted with 24 flutes, with fillets between, whoſe breadths are equal to $\frac{1}{3}$ of a flute.

2. The entablature is $\frac{1}{4}$ of the altitude of the column, and its corniſh is always adorn'd with denticules.

3. The height of the pedeſtal is two diameters and $\frac{2}{3}$, and its intercolumnation two diameters and $\frac{1}{4}$, which is the moſt elegant manner of intercolumnation, and by *Vitruvius* is called *Euſtillos*.

Laſtly, The diminution of the ſhaft is $\frac{1}{6}$ of the diameter at the baſe of the ſhaft.

IV. Of

IV. Of the Corinthian order.

The Corinthian order is the very pride and delicacy of all the other orders. It was firſt deſign'd by an architect of *Athens*, and executed at *Corinth*, a noble city of *Peloponneſe*, or *Morea*, from whence it had its original and name of Corinth in order.

The proportion, diminution, and intercolumnation of this beatiful order, is as follows.

1. The ſhaft with its baſe and capital is 9 diameters and a half, and ſometimes 9 and $\frac{3}{4}$, and oftentimes 10 diameters in length. If the ſhaft be fluted, the flutes muſt be made according to problem XV. ſect. I. hereof.

2. The height of the capital is one diameter of the ſhaft at the baſe, of which the abacus muſt be a ſixth, or ſeventh part, and the remaining quantity being divided into 3 equal parts, the two lowermoſt is the true height of the firſt and ſecond toure of leaves, and the third or uppermoſt part being divided into two equal parts, the upper part of thoſe two parts ſhall be the extreams of the volutas and the lower the cauliculi.

3. The height of the entablature is $\frac{1}{5}$ of the column, including the baſe and capital, except when applied to great and magnificent buildings, as the *Roman Pantheon*, &c.

4. The height of the pedeſtal muſt be $\frac{1}{4}$ of the altitude of the column, and the diminution of the ſhaft $\frac{1}{7}$ of the diameter at its baſe.

5. The intercolumnation is two diameters and $\frac{1}{4}$, as in the preceding order of the Ionick.

V. Of the Compoſite order.

The Compoſite order, is of Roman extraction, and by many called the *Italian* order, and oftentimes the *Roman* order. 'Tis compoſed of the Ionick and Corinthian orders, and therefore is called the compoſed order.

The proportion, diminution and intercolumnation of this order, is as follows.

1. The ſhaft, with its baſe and capital, is ten diameters in length, or height; and its entablature $\frac{1}{4}$, or $\frac{1}{5}$, thereof.

Its

its diminution at the head of the ſhaft is $\frac{1}{8}$ of the diameter at the baſe, and its intercolumnation one diameter and $\frac{1}{2}$, or $\frac{3}{4}$.

The height of the pedeſtal is generally equal to $\frac{1}{3}$ of the column's altitude, and its baſe is either attick, or a compound of the attick and ionick.

And altho' theſe proportions of all the five orders are thus eſtabliſhed, yet not with ſo great a ſtrictneſs, but that the architect may vary therefrom, upon juſt occaſions, as the grandeur and conveniency of a building may require.

SECT. III.

Of Architectonical Axioms and Analogies.

I. Of doors.

THat the height of all doors be double their breadth.

That doors in general be proportional to the magnitude of the rooms.

That the breadth of inner doors be never leſs than 2 feet $\frac{1}{2}$, nor more than 6 feet.

That the doors of the 2d ſtory be placed exactly over the doors of the firſt, and the like of the 3d, &c.

That an arch of brick or ſtone be turned over every door, to diſcharge the weight that preſſes upon them, which oftentimes ruines the ſtructure.

II. Of windows.

That the magnitude and number of windows be proportional to the rooms that they are to illuminate.

That the height of every window in the firſt ſtory be double its breadth, with the addition of $\frac{1}{4}$, $\frac{1}{3}$ or $\frac{1}{2}$ part, as found to be neceſſary.

That the height of the windows in the 2d ſtory be $\frac{11}{12}$ of the firſt, and the height of the attick or 3d ſtory $\frac{3}{4}$ of the ſecond ſtory.

That windows be not placed too near the angles of any building, that thereby the ſtructure be not weaken'd.

That over every window be turn'd an arch to diſcharge the weight that lies over them.

That no girder be laid over any door or window, but always on the moſt ſubſtantial part of the brick or ſtone peers, &c. that ſolid may reſt upon ſolid.

That *Venetian* windows have their proportions, as follow, *viz.* (fig. IX. plate VII.) that the height A B be equal to twice E F, and that G H and C D be each equal to $\frac{1}{2}$ E F.

That the centers of all pediments be placed down the centeral line at the diſtance of $\frac{1}{2}$ the length of the corona. So the point *c* of fig. X. plate VII. is the center of that pediment, being the diſtance of *a*, *b*, ſet down to *c* and the like of all others in general.

III. Of gates.

That the breadth of principal gates of entrance be never leſs than 7 feet $\frac{1}{2}$, nor more than 12 feet.

That the height of principal gates of entrance be never leſs than their breadth and $\frac{1}{2}$, nor more than twice, which is the beſt proportion.

IV. Of halls.

That the length of halls, be not leſs than twice their breadth, nor more than three times.

That the height of halls, whoſe cielings are flat, be not leſs than $\frac{2}{3}$ of the breadth, or more than $\frac{3}{4}$ of the length.

That the height of halls whoſe cielings are arched be not leſs than $\frac{5}{6}$, nor more than $\frac{11}{12}$ of their breadth.

V. Of galleries.

That their ſite be towards the *North*, on account that the *North* light is the beſt for painting, pictures, &c.

That the breadth of galleries be not leſs than 16 feet, nor more than 24.

That the length of galleries be not leſs than 5 times their breadth, nor more than eight at moſt.

That the height of galleries be equal to their breadth, if with flat cielings, but if arched, the breadth and $\frac{1}{5}$, $\frac{1}{4}$ or $\frac{1}{3}$.

VI. Of antichambers.

That the length of all antichambers be equal to the hypothenuſe of a right angled plain triangle, whoſe legs are each equal to the breadth of the antichamber.

That

That the breadth of all antichambers be proportional to the whole ſtructure. That the height of antichambers be not leſs than $\frac{2}{3}$ of the breadth, or more than $\frac{3}{4}$ of the length, when the cieling is flat, and when arched, to be not leſs than $\frac{5}{6}$, nor more than $\frac{11}{12}$ of their breadth.

VI. Of chambers.

That all principal chambers of delight be placed towards the beſt proſpects of the country, and if poſſible to the *Eaſt*.

That the length of chambers never exceed the breadth and $\frac{1}{5}$ of the breadth; therefore the length may be the breadth exactly, or the breadth and $\frac{1}{8}$, $\frac{1}{7}$, $\frac{1}{6}$ or $\frac{1}{5}$.

That the height of all chambers of the firſt ſtory, whoſe cielings are flat, be not leſs than $\frac{2}{3}$ of the breadth, or more than $\frac{3}{4}$ of the length.

That the altitude of chambers in the ſecond floor be $\frac{11}{12}$ of the firſt ſtory.

That the altitude of the chambers in the third floor be $\frac{3}{4}$ of the ſecond.

VII. Of Floors.

That the floor of every ſtory in a building be truly level throughout, ſo as to paſs out of one room into another, without going up or down ſtairs, as is common in many buildings.

That the height of the level of the firſt (or ground) floor, be never leſs than one foot, nor more than four feet.

VIII. Of chimneys.

1. Of hall chimneys.

That the proportion of hall chimneys be as follows, *viz.* Their diſtance between the jaums from 6 to 8 feet; their height from 4 feet $\frac{1}{2}$ to 5 feet; their projection from 2 feet $\frac{1}{2}$ to 3 feet at moſt; the breadth of the jaums from 8 to 24 inches or more, as occaſion may require, according to the order that the chimney is adorned with.

2. Of chamber chimneys.

That the proportion of chamber chimneys be as follows, *viz.* their breadth from 5 to 7 feet, their height 4 feet $\frac{1}{2}$, and projecture 2 feet and $\frac{1}{2}$.

3. Of

3. Of chimneys in ſtudies, &c.

That the proportion of chimneys in ſtudies be as follows, *viz.* their breadth from 4 to 5 feet at moſt; their height 4 feet $\frac{1}{3}$, and projecture 2 feet $\frac{1}{2}$.

That the funnels of chimneys of chambers, or ſtudies, be not narrower than 10 inches, or wider than 15, which is a good ſize for kitchin chimneys.

IX. Of the funnels of chimneys.

That the funnels of chimneys be carried a ſufficient height above the ridge, that reflex winds may not repulſe the ſmoke.

That the funnels of chimneys be not wide, whereby the wind may drive down the ſmoke into the room, or too narrow, where it cannot have a free paſſage.

That the funnels of chimneys be truly perpendicular, otherwiſe the ſmoke cannot freely paſs, and thereby will be offenſive.

That no timber, joiſt, &c. be laid nearer to the jaums than one foot.

That no trimming joiſts be laid nearer than 6 inches to the back of any chimney.

That the funnels of all chimneys have not any timber, as girders, joiſts, &c. laid therein, otherwiſe the building will be in danger of being reduced to aſhes.

X. Of joiſts, rafters, and girders.

That the greateſt diſtance that joiſts, or rafters, are laid from each other, do not exceed 12 inches, and quarters 14 inches.

That no joiſt bear at a greater length than 12 feet, or ſingle rafters more than 10 feet.

That the length of joiſts laid in the wall be not leſs than 9 inches, and no girder be leſs than 12 inches.

XI. Of ſtair caſes.

That ſtair caſes be ſpacious, light and eaſy in aſcent.

That the breadth of ſtair caſes be not leſs than 4 feet, or more than 12 feet.

That the height of ſteps be never leſs than 4 inches, or more than 6.

That the breadth of ſteps be never more than 18 inches, or leſs than 12 inches.

XII. Of

XII. Of materials, &c.

1. That money and materials be always ready from the beginning, or laying of the foundation, to the turning of the key when the whole is completed.

2. That great care be taken in the goodneſs of foundations, and that they be truly level.

3. That the thickneſs of all foundations be double to the inſiſtent wall.

4. That the moſt heavy materials be imployed in the foundations.

5. That all walls diminiſh in thickneſs, according to the nature and height of the ſtructure.

6. That every wall be perpendicular.

7. That ſuch bricks as are not well burnt, be not uſed in any building.

8. That the depth of all fabricks in the ground that have cellars, vaults, &c. be $\frac{1}{7}$ of the whole height, and thoſe that have no cellars to be $\frac{1}{6}$ of the height.

9. That the kitchin be ſpacious and light, and as remote from the parlor as poſſible, and to be under ground; as alſo the pantry, bake-houſe, ſtill-room, buttry, dairy, and ſervants offices in general.

10. That corniſhes do not project too far out from the building, whereby the windows be darken'd.

11. That of all kind of arches none is ſo ſtrong as the ſemicircle.

12. That the depth of all ruſticks be never more than 1 foot, nor leſs than 9 inches.

13. That the thickneſs of pillaſters, of doors and windows, be not more than $\frac{1}{5}$ of their aperture, nor leſs than $\frac{1}{6}$.

14. That the projecture of pillaſters in general, be ^{1} of their thickneſs.

15. That the roofs of all buildings be not too heavy, or too light, and that the interiour walls ſupport part of the ſame.

16. That convenient ciſterns be well placed, plentifully to furniſh every office with water, and that proper machines be made to raiſe the ſame therein.

Laſtly, That convenient drains, to carry away ſoil, &c. be well contrived, and ſecretly placed, with vents to diſcharge the noiſome vapours.

SECT. IV.

PLATE X.

Of the Deſcription and Uſe of an inſpectional plain Scale, for delineating Architecture, Gardening, &c.

THIS ſcale being deſigned but for the drawing of architecture and gardening, it is therefore made to ſuch a breadth and length as is ſuitable to the magnitude of any draught whatſoever. And although this inſtrument was deſigned for drawing only, yet it may, with a great deal of eaſe and delight, be applied to the practice of architecture, which at the end hereof I ſhall demonſtrate. In the uſe of this inſtrument 'tis required to have ſuch a te-ſquare as is uſed with a drawing table, well known by all architects, &c. and the breadth thereof muſt be exactly equal to $\frac{1}{2}$ the breadth of the inſtrument. The lines on this ſcale are of two kinds, *viz.* parallel, as the lines *a*, *a*, *a*, &c. and centeral, as the lines of the trigons G H I K L, and the chords over the trigons M G I. The parallelogram C D E F, repreſents $\frac{1}{4}$ of a pillaſter or column, and C E its ſemidiameter, and conſequently either C D or E F, the centeral line of the pillaſter or column. The diagonal ſcale at the end thereof is treble; for *firſt* you have an inch in a hundred parts, *ſecondly* an $\frac{1}{2}$ inch, and *laſtly* $\frac{1}{4}$ of an inch in the ſame proportion. Which ſcales are of great uſe in delineating maps, that were meaſured with *Gunter*'s chain, which is divided into 100 links. The trigon adjoining thereunto hath its baſe divided into 90 unequal parts, and is a line of chords from which, to the center, are drawn right lines, which divide the ſeveral parallels therein in the ſame proportion, and thereby you have 20 lines of chords to 20 different radius, &c. The diagonal lines C F and E D are drawn, to ſet thereon the half length of any column or pillaſter. The diagonal E D is to be uſed, when any queſtion is to be anſwered by the trigons I K, and the other diagonal C E, when by the trigons M G H L. The trigon G hath both its ſides equal to the ſemidiameter C E, whereof the outward is divided into 30 equal parts, each repreſenting a minute, from which are centeral lines

drawn to the center, which divide all parallel right lines drawn therein, in the ſame proportion.

The trigon H hath its ſide oppoſite to the center divided in ſuch proportion, as the whole breadth of a pillaſter is divided by its 8 fillets and 7 flutes; from which diviſions are lines drawn to the center, which alſo divide any line that is parallel to the outſide, in the very ſame proportion.

The trigons I and K, are divided after the ſame manner, as that of I in the diviſion of the diameter of a column with flutes only, and that of K with its flutes and fillets.

The trigons L and M are made, to furniſh the young ſtudent with ſcales of all ſizes, either for meaſures of feet and inches, as that of L, or feet only, as that of M.

Problem I.

The height of a pillaſter, or column, being given, to find the ſemidiameter thereof, divided into its 30 min. by which the whole pillaſter, or column, with its architrave, freize, and corniſh is meaſured.

Let A B be the half height of a column given, to find the ſemidiameter divided into minutes.

Practice.

1. Lay your te-ſquare on the inſtrument, and taking A B in your compaſſes, move the edge of your ſquare to the outſide at C, and at C make a mark on the ſquare exactly over the line C E, and from that mark ſet off the diſtance of A B taken in your compaſſes, on the edge of the ſquare as at X.

2. Slide back the ſquare, 'till the point X lie over the diagonal C F, in the point Y, and then ſhall that edge of the ſquare that lies over the trigon G be the ſemidiameter of the given column, and the centeral lines be divided into 30 min. as required.

☞ 'Tis beſt, when the diameter is thus found, to draw a fine line with a black lead pencil by the ſide of the ſquare, over the whole breadth of the trigon, and then you may take away the ſquare and work from the diviſions of the black lead line, as occaſion requires.

Problem

PROBLEM II.

The height of a pillaſter being given, to find its breadth, and diviſion into 7 flutes and 8 fillets.

Practice.

1. Let it be required to find the breadth and diviſion of the pillaſter, whoſe $\frac{1}{2}$ height is equal to the aforeſaid given line AB.

2. Place the point X on Y (as before) and then will the other edge of the ſquare cut the trigon H in the point *n n*.

3. The line *n n* is the breadth of the pillaſter, and its diviſions, by the centeral lines, are the true breadths of every flute and fillet, as required.

PROBLEM III.

The height of a column being given, to find the diameter, and meaſure (or true breadth) of every flute and fillet, contained in the geometrical upright of the ſame.

The trigon for flutes and fillets is the trigon K, therefore you muſt uſe the diagonal E D.

Let the height of the column be (as afore) equal to twice the given line A B.

1. Place the $\frac{1}{2}$ height C X at Z, then will the other edge of the ſquare cut the trigon K in the points *n n*.

2. The line *n n* is the diameter, or breadth, of the column, and its diviſions by the centeral lines, the true breadths of every flute and fillet, as required.

PROBLEM IV.

To find the true meaſures of the flutes contained in the geometrical upright of a column, that is fluted without fillets (as often practiced in the dorick order) to any height aſſigned.

Let the height of the column be as aforeſaid, equal to twice the given line A B.

1. Place the point X over Z, then will the other edge of the ſquare, cut the trigon I in the points *o* and *o*.

2 The line *o o* is the diameter of the column, and its diviſions, by the centeral lines, are the true breadth of every flute, as required.

☞ *Note*, That to find the breadth, or magnitude of the flutes and fillets, &c. at the top of the column, where they are narrower than at the baſe, you muſt place the

the diameter upon the reſpective trigon, ſo as to interſect the ſides and be parallel to the baſe hereof, and the lines of the trigon will divide the diameter into its true diviſions of flutes and fillets, &c. as required. And the like of any other part of the column whatſoever.

Problem VI.

To reduce any part of a line, as a model, minute, &c. *into feet and inches, and thereby make this inſtrument univerſal in practice.*

Let *a b*, in the trigon L, repreſent 5 inches, and 'tis required immediately to find a ſcale of 12 inches ſuitable to it, whereby any part may be meaſured by feet and inches.

1. Take the line *a b* in your compaſſes.

2. Fix the edge of the ſquare to the center H of the trigon L, and ſet off the line *a b*, on the edge of the ſquare from H to *i*.

3. Move the ſquare towards the line 1, 2, 3, &c. 'till the point *i* exactly lie over the line H 5 (as on the point E) and draw by the edge of the ſquare the line I K, which by the 12 centeral lines will be divided into 12 equal parts, (5 of which are equal to the given line *a b*) and is the ſcale of 12 inches ſuitable, or proportionable to the line *a b*, as required.

A ſecond example.

Suppoſe C E *to repreſent* 20 *inches, how to find a ſcale of* 12 *inches proportionable thereunto.*

Practice.

1. The $\frac{1}{2}$ of 20 is 10, therefore lay the edge of the te-ſquare to H (as in the laſt example) and ſet off the $\frac{1}{2}$ of C E.

2. Move back the edge of the ſquare till the point, or $\frac{1}{2}$ of C E, cut the line H 10.

3. The edge of the ſquare being not moved, draw a line by the ſame through the trigon L, which by the 12 centeral lines will be divided into 12 equal parts, repreſenting inches, and proportional to C E that contains 20 inches, as was required to be done.

☞ When your column, or pillaſter, contains any number of odd inches, radius or diameter, as 27, &c. take $\frac{1}{3}$, &c. thereof, as 9, &c. and find the ſcale

for that number, and that ſcale ſo found ſhall be the ſcale proportionable to 27, as required.

The trigon M is an infinite number of ſcales each divided into tenths, by the 10 central lines, as may be at once underſtood by a ſingle view of the ſame. Theſe decimal ſcales are of great uſe in meaſuring plans of gardening, and ſmall encloſures, taken by foot meaſure. And

The trigon L which is alſo an infinite number of ſcales of twelfths, is of great uſe in meaſuring plans of buildings taken by feet and inch meaſure, which I recommend to the young ſtudent for the very beſt plain ſcale that was ever yet made publick. The excellency and uſe of it will be demonſtrated in the ſeveral parts of this work, as they have relation thereunto.

SECT. V.

PLATE XI.

Of plain Trigonometry.

I. Of right lined triangles.

Fig. I. RIght lined triangles are diſtinguiſhed by the difference of their ſides, or by the difference of their angles. As to the difference of their ſides, they may be all equal, as A, which is called an equilateral triangle, or two ſides may be equal and the third unequal, as B, which is called an iſoſceles triangle, or all the ſides may be unequal as C, which is called a ſchalenum triangle. And theſe are the diſtinctions, in reſpect to their ſides. The diſtinctions of triangles, in reſpect to their angles, are three alſo.

1. When a triangle hath one angle right, as D, 'tis called an orthogonium triangle.

2. When the triangle hath all the angles acute as A, 'tis called an oxogonium triangle.

3. When a triangle hath one angle obtuſe as C or B, 'tis called an abligonium triangle. And theſe are the diſtinctions, in reſpect to their angles.

II. *Of trigonometrical definitions.*

Fig. I. 1. Any two ſides of a triangle are termed, or called, the ſides of that angle. So the ſides F G and E G are the ſides containing the angle F G E. 2. Every

2. Every ſide of a triangle is the ſubtending ſide of the angle which is oppoſite to it. So in the triangle F G E the ſide F G ſubtends the angle at E, and the ſide E F ſubtends the angle at G, and the ſide E G the angle at F. For in all plain triangles, the greateſt ſide always ſubtends the greateſt angle, and the leſſer ſide the leſſer angle, and equal ſides equal angles.

3. The meaſure of an angle is an arch of a circle deſcribed upon the angular point, and is intercepted between the two ſides that contain the angle. So the meaſure of the angle H I K is the arch *c c*. See the demonſtration of problem II. ſect. I. part II.

4. Every circle is divided into 360 degrees, and each degree into 60 min. See problem XXX. ſect. II. part. I.

5. A quadrant is $\frac{1}{4}$ of a circle. See definition 16. ſect. I. part. I.

6. The complement of an arch, leſs than a quadrant, is ſo much as an arch wanteth of 90 degrees. So the complement of the arch C L is H C.

7. The exceſs of an arch greater than a quadrant, is ſo many degrees as the arch exceedeth 90 deg.

8. A ſemicircle. See defi. 16. ſect. I part. I.

9. The complement of an arch, leſs than a ſemicircle, to a ſemicircle, is ſo much as the arch wanteth of 180 deg.

10. If a triangle have ſome of its ſides equal, it is either equicrural or equilateral.

11. An equicrural triangle is that which hath two ſides equal, and the third unequal.

12. An equilateral triangle. See the beginning hereof.

13. A triangle is either right angled, or oblique angled.

14. A right angled plain triangle is that which hath one right angle and two acute ones.

15. An oblique angled plain triangle is that which hath all its angles oblique, *viz.* one obtuſe, and two acute.

16. In all plain triangles, the ſum of all the angles are equal to a ſemicircle, or 180 degrees.

17. The third angle of any plain triangle is the complement of the other two, to two right angles, or 180 degrees.

III. *Of the conſtruction of ſuch right lines as are applied to a circle, for the ſolution of right lined triangles.*

The right lines applied to a circle for the ſolution, or calculation of right lined triangles, are chords, ſines, tangents, half tangents, ſecants and verſed ſines, which may be projected to any aſſign'd radius, as follows. PLATE

PLATE XI.

Geometrically.

Fig. II. 1. A chord, or ſubtenſe, is a right line, joining the extremity of an arch. So A C is the chord of the arch A M C.

2. A line of chords, is no more than 90 deg. of the arch of any circle transfer'd from the limb to a right line.

Conſtruction.

1. Draw the right line N V and biſſect it in O, whereon, with the diſtance O N, deſcribe the ſemicircle M N V, and on O erect the perpendicular O M, and by problem XXX. ſect. II. part I. divide the ſemicircle into 180 deg.

2. On V place one foot of your compaſſes, and open the other firſt to 10 deg. on the ſemicircle, and deſcribe the arch 10, 10, and with the opening V 20 the arch 20, 20, and the like at every degree; and thereby you'll transfer the chords from the quadrant V M, to the diameter or right line N V, which is the line of chords required.

3. A right ſine is a right line drawn from the end of an arch, perpendicular to the diameter, through to the other end, or 'tis half the chord of twice the arch.

Conſtruction.

1. From 10 deg. on the one ſide of the ſemicircle to 10 deg. on the other ſide, draw the right line 10 L 10, interſecting the perpendicular O M in L.

2. Perform the like operation throughout the ſeveral degrees, and thereby you will divide the line O M into the line of ſines, as required.

4. A tangent is a right line perpendicular to the diameter, drawn by the extream of the given arch, and terminated by the ſecant drawn from the center, thro' the extream of the ſaid arch.

Conſtruction.

On the point V erect the perpendicular V Y, and to it draw right lines from the center O, thro' each degree of the quadrant O M V, which lines, ſo drawn, ſhall divide the perpendicular V Y into unequal parts, and ſhall be the tangents required.

5. A ſecant is a right line drawn from the center thro' one extream of the given arch, 'till it meet with the tangent, as the ſecant E 60, &c.

6. Half tangents are no other than whole tangents, numbered double, as calling 30 min. a whole $\frac{1}{2}$ tangent, and one whole tangent 2 $\frac{1}{2}$ tangents, and therefore 45 deg. of whole tangents is called 90 deg. of $\frac{1}{2}$ tangents, &c.

7. A verſed ſine is a ſegment of the diameter, intercepted between the right ſine, and the ſine of 90 deg.

IV. *Of divers affections incident to plain triangles.*

1. A plain triangle is contained under 3 right lines, and is either right angled or oblique angled.

2. In all plain triangles two angles being given, the third is alſo given.

3. In the analyſis of plain triangles, the angles only being given the ſides cannot be found but by the reaſon or proportion of them. Therefore 'tis wholly requiſite that one ſide be known.

4. In a right angle triangled two terms (beſides the right angle) will ſuffice to find the third, ſo that one of them be a ſide.

5. In oblique angled plain triangles there muſt be three terms given to find a fourth.

6. In right angled plain triangles there are 7 caſes, and in oblique angled plain triangles 5 caſes.

V. *Of axioms for the ſolution of the* 12 *caſes following.*

Axiom I.

If in a right angled plain triangle, the hypotenuſe be made radius, each leg will be the ſine of its oppoſite angles, but if one leg be made radius, the hypotenuſe will be the ſecant, and the other leg a tangent thereunto.

Axiom II.

In all plain triangles the ſides are proportional to the ſines of their oppoſite angles.

Axiom III.

As the ſum of the ſides of any angle is to their difference; ſo is the tangent of half the ſum of their oppoſite angles, to the tangent of half their difference.

AXIOM IV.

Fig. II. As the baſe or longeſt ſide is to the ſum of the other ſides, ſo is the difference of thoſe ſides to the difference of the ſegments of the baſe.

VI. *Of the ſolution of the 7 caſes of right angled plain triangles.*

In right angled plain triangles, I call thoſe ſides which comprehend the right angle, one the baſe (*viz* the longeſt) and the other the perpendicular, and the ſlope-line, or ſide ſubtending the right angle, the hypotenuſe.

Caſe I.

PLATE VII.

The baſe A B 80, *and the perpendicular* A C 60, *given to find the angle* B C A.

Solution. 1. Geometrically.

Fig. II. 1. Delineate B A equal to 80 equal parts of any plain ſcale, and on A erect the perpendicular A C, and make it equal to 60 equal parts from the ſame ſcale as you laid down B A.

2. From the extreams of the baſe at B, and perpendicular at C, draw the hypotenuſe C B.

3. On C, with 60 degrees of a line of chords, deſcribe the arch *a a*, and taking the quantity *a n*, in your compaſſes, and applying it to your line of chords, you will find it to contain 53 : 00 the angle required.

2. *By* Trigonometrical *calculation.*

Analogies.

Firſt, as the perpendicular C A 60, is to the baſe B A 80, ſo is the tangent of 45 degrees, to the tangent of 37 deg. whoſe complement to a quadrant, or 90 deg. is 53 deg. the angle required. Or,

Secondly, As B A 80 is to the tangent of 45 deg. ſo is A C 60 to the tangent of 37 deg. whoſe complement is 53 deg. the angle required.

Caſe II.

The baſe A B 80, *and the angle* B C A, 53 *deg. given, to find the perpendicular* A C.

Solution.

Solution. 1. Geometrically.

1. Delineate the baſe A B and make it equal to 80, and on A erect the perpendicular A D. Fig. III.

2. Make the arch *n m*, equal to the complement of the given angle, and through *m* draw the hypotenuſe B C, which will interſect the perpendicular in C.

3. The diſtance C A, being laid on your ſcale of equal parts, will be found to be 60, which is the length required.

2. *By* Trigonometrical *calculation.*

Analogy.

As the ſine of the angle B C A 53 deg. is to the baſe B A 80, ſo is the coſine, or complement, of the angle B C A 37 deg. to the perpendicular C A 60, as required.

Caſe III.

The hypotenuſe B C 100, *and the baſe* B A 80 *given, to find the angle* B C A.

Solution. 1. Geometrically.

1. Make B A equal to 80, and on A erect the perpendicular A D, and on B, with the length of the hypotenuſe B C, deſcribe the arch *o m*, interſecting the perpendicular in C. Fig. IV.

2. On C, with 60 deg. of your line of chords, deſcribe the arch *r s*, and take the arch *r s*, and meaſure it on your line of chords, and it will contain 53 deg. the angle required.

2. *By* Trigonometrical *calculation.*

As the hypotenuſe B C 100, is to the radius, or ſine of 90 deg. ſo is the baſe B A 80, to the ſine of 53 deg. the angle required.

Or thus.

As B A 80, is to B C 100, ſo is the radius to the ſine of the complement of 53 deg. the angle required.

Caſe IV.

The hypotenuſe B C 100, *and the angle* B C A 53 *deg. given, to find the baſe.*

Solution.

Solution. 1. Geometrically.

Fig. V. 1. Draw A C at pleaſure, and on C, with 60 deg. of your line of chords, deſcribe the arch *n n*, and make the angle C equal to 53 deg. the angle given, and draw the hypotenuſe B C equal to 100.

2. On B, with 60 deg. of chords, deſcribe the arch *o o*, and make the angle B equal to the complement of C, and draw B A, which ſhall cut C A, the perpendicular in A, and being meaſured on your ſcale of equal parts, will contain 80, the length required.

2. *By* Trigonometrical *calculation.*

As the radius, or ſine of 90 deg. is to the hypotenuſe B C 100, ſo is the ſine of the angle B C A 53 deg. to the baſe 80, as required.

Or thus.

As the radius, or ſine 90 deg. is to the ſine of the angle B C A 53 deg. ſo is B C the hypotenuſe 100, to the baſe 80, as required.

Caſe V.

The angle A B C 37 *deg. and the perpendicular* A C 60 *given, to find the hypotenuſe* B C.

Solution. 1. Geometrically.

Fig. VI. 1. Draw A B at pleaſure, and on A erect the perpendicular A C equal to 60, and on C, with 60 deg. of chords, deſcribe the arch *i i*, and make the angle C equal to 53 deg. the complement of the given angle, and draw the hypotenuſe C *i* B, which will interſect the baſe B A, in B, and being meaſured on your ſcale of equal parts will contain 100, as required.

2. *By* Trigonometrical *calculation.*

As the ſine of the angle A B C 37 deg. is to the perpendicular A C 60, ſo is the radius, or ſine of 90 deg. to B C the hypotenuſe 100, as required.

Caſe VI.

The hypotenuſe B C 100, *and the perpendicular* A C 60, *given, to find the baſe* B A.

Solution. 1 Geometrically.

1. Draw B A at pleaſure, and on A erect the perpendicular A C, and make it equal to 60, and on C, with the length of the hypotenuſe, deſcribe the arch *b b*, interſecting the baſe in B. Fig. VII.

2. The length B A is the baſe required.

2. *By* Trigonometrical *calculation.*

Analogy.

As the hypotenuſe B C 100, is to the radius, or ſine of 90 deg. ſo is the perpendicular A C 60, to the ſine of 37 deg. the angle A B C. Then

As the radius is to the hypotenuſe 100, ſo is the coſine of the angle A B C 53 deg. to B A 80, the baſe required.

Or thus.

Multiply the perpendicular into it ſelf as alſo the hypotenuſe, and ſubſtract the leſſer product from the greater, then ſhall the ſquare root of the remainder be the length of the baſe required.

Caſe VII.

The baſe B A 80, *and the perpendicular* A C 60 *given, to find the hypotenuſe.*

Solution. 1 Geometrically.

1. Make A B equal to 80, and on A erect the perpendicular A C, equal to 60. Fig. VIII.

2. From B to C draw the hypotenuſe required.

2. *By* Trigonometrical *calculation.*

Analogies.

As the perpendicular A C 60 is to the tangent of 45 deg. ſo is B A the baſe 80 to the tangent of 37 deg. the angle A B C. Then

As the cotangent of 37 deg. is to the baſe B A 80, ſo is the tangent of 45 deg. to the hypotenuſe B C 100, required.

Or thus.

By theorem V. ſect. III. part. I. multiply the baſe into its ſelf, as alſo the perpendicular, and add both the pro-

ducts together, then ſhall the ſquare root of that ſum, be the hypotenuſe required.

VII. *Of the ſolution of the 5 caſes of oblique angled plain triangles.*

Caſe I.

The ſides B C 50 *and* C A 60 *with the angle* A B C 27 *deg. given, to find the angle* C A B.

Solution. 1 Geometrically.

Fig. IX. 1. Draw B A at pleaſure, and make the angle A B C equal to the given angle, and make B C equal to 50.

2. On C, with the diſtance of C A 60, deſcribe the arch *t t*, interſecting the baſe in A, whereon, with 60 deg. of chords, deſcribe the arch *a m*, which being meaſured on the line of chords, will be equal to 22 deg. 30 min. the angle required.

2. *By* Trigonometrical *calculation.*

Analogies. By axiom II.

As the ſide C A 60, is to the ſine of the angle A B C, 27 deg. ſo is the ſide B C 50, to the ſine of 22 deg. 30 min. the angle required.

Or thus.

As the ſide B C 50, is to the ſide C A 60, ſo is the ſine of 27 deg. the angle A B C, to 22 deg. 30 min. the angle required.

Caſe II.

The ſides B C 50, *and* C A 60, *with the angle* A C B 131 *deg.* 30 *min. given, to find the other angles* C A B *and* A B C.

Solution. 1. Geometrically.

Fig. X. 1. Delineate B C and C A, making the angle C equal to the given angle.

2. Join A B the baſe, and with 60 deg. of the line of chords on the points A and B, deſcribe the arches *o p* and *q r*, which being ſeverally meaſured on the line of chords, will be the quantity of the angles required.

2. *By* Trigonometrical *calculation.*

Analogie. By axiom III.

As the ſum of the ſides B C and C A 100, is to their difference,

difference, *viz.* 10. ſo is the tangent of $\frac{1}{2}$ the oppoſite angles 24 deg. 45 min. to the tangent of $\frac{1}{2}$ their difference, *viz.* 2 deg. 45 min. Then

This $\frac{1}{2}$ difference ſubſtracted from the $\frac{1}{2}$ ſum of the oppoſite angles gives the inferior angle; but added to the $\frac{1}{2}$ ſum of the oppoſite angles gives the ſuperior angle.

Or thus.

As the $\frac{1}{2}$ ſum of the given ſides is to their $\frac{1}{2}$ difference, ſo is the tangent of $\frac{1}{2}$ the oppoſite angles to the tangent of $\frac{1}{2}$ their difference.

Then add and ſubſtract as before directed.

Caſe III.

The angle A B C *and* C A B, *with the ſide* B C 50, *oppoſite to the angle* C A B *given, to find the ſide, or baſe* A C.

Solution. 1. Geometrically.

Fig. XI.

1. Make B C equal to 50, and make the angle C B A equal to 131 deg. 30 min. as given, and draw B A infinitely.

2. Make the angle B C A equal to the complement of the two given angles, to 180 deg. and draw A C, which will interſect B A in A.

3. The line A C is the baſe required, and if meaſured on your plain ſcale, will be equal to 100 of thoſe parts, as B C contains 50.

2. *By* Trigonometrical *calculation.*

Analogy. By axiom II.

As the ſine of the angle C A B 27 deg. is to the ſide B C 50, ſo is the ſine complement of the angle A B C, *viz.* 49 deg. to 30 min. the baſe 100.

Caſe IV.

The ſides B C 60, *and* C A 100, *with the angle* C 22 *deg.* 30 *min. comprehended by them given, to find the ſide* A B.

Solution. 1. Geometrically.

Fig. XII.

1. Make A C, B C, and the angle C, equal to the meaſures given, and from their extreams draw A B, and it ſhall be the ſide required.

2. *By*

2. *By* Trigonometrical *calculation.*

1. Find the angle at A, by axiom I. or II. then the analogy is thus, as the ſine of the angle C A B is to B C; ſo is the ſine of the angle A C B to the ſide A B, required.

Caſe V.

The 3 *ſides* A C 100, A B 50, B C 60, *given, to find the angle* B C A, *or the angle* C A B.

Solution. 1. Geometrically.

Fig. XIII. 1. By problem XIV. ſect. II. part I. delineate the triangle A B C equal to the 3 given ſides.

2. With 60 deg. of chords on A and C, deſcribe the arches *n n* and *r r*, which being meaſured on the line of chords, will ſhew the quantity of each angle as required.

2. *By* Trigonometrical *calculation.*

For the ſolution of this caſe, two operations are required, *viz.* the firſt, to find the ſegment of the baſe A D and D C, and the ſecond to find the angles required.

Analogy. Firſt by axiom IV.

As the ſum of the baſe A C 100, is to the ſides A B and B C 110, ſo is the difference of A B and B C, (*viz.* 10) to the difference of the ſegments of the baſe (*viz.* 14.) This ſegment added to the baſe, *viz.* 100, the ſum is 114, whoſe $\frac{1}{2}$, *viz.* 57, is the ſuperiour ſegment D C, which being ſubſtracted from A C 100, leaves A D 43 the leſſer ſegment. And now there are conſtituted two right angled plain triangles, by which the angles may thus be found, by this analogy of caſe III. of right angled plain triangles.

Analogy.

As the hypotenuſe B C 60, is to the radius, or ſine of 90 deg. ſo is the greater ſegment D C 57, to the angle D B C, whoſe complement to 90 deg. is the angle B C A, required.

Again,

As the hypotenuſe B C 60, is to the radius, ſo is the leſſer ſegment A D 43, to the angle D B A, whoſe complement to 90 deg. is the angle B A C, required

☞ I adviſe that the young ſtudent be perfect in theſe 12 caſes, before he proceed any further. For hereon depend not only the principles of framing all kinds of roofs of buildings, meaſuring all kinds of heights and diſtances, acceſſible, or inacceſſible, ſurveying of land, meaſuring, &c. but alſo of navigation, fortification, and gunnery, which ſome youths may delight in the ſtudy of, beſides the ſubjects hereof, they being both profitable and delightful.

SECT. VI.

Of the Geometrical Conſtruction of Draughts, Plans, and Maps of Lands, Gardens, Farms, Buildings, &c.

TO enumerate the many mathematical inſtruments invented for this purpoſe, and to deſcribe their uſe would be but a needleſs amuſing work, ſeeing that herein the only inſtruments that I make uſe of are the common *Gunter*'s chain, and a common five and ten foot rod, divided into feet and inches, &c. with which I ſhall ſhew how to deſcribe any plan, with much leſs trouble and in much leſs time than by the help of any theodilite, plain table, circumferentor, &c. and, if I miſtake not, far more exact.

When the meaſure of any length is taken by a chain, and contains 10 chains 73 links, 'tis thus written 10 : 73, ſo alſo is 73 chains 4 links, thus 73 : 04; and when any length is meaſured that is leſs than a chain's length, as 73 links, 'tis either written thus 00 : 73, or thus : .73, with a period or full ſtop before it, in the ſame manner, as a decimal fraction.

☞ The reaſon why the links are often times expreſs'd according to the laſt way, is, becauſe in taking the meaſures of offsets, (which are very often under the length of a chain) there is no room to expreſs them according to the former way, between the offsets taken. See the meaſures of the offsets taken from the line LK, fig. XXI. plate XI. where may be ſeen, at one view, a demonſtration thereof.

The appurtenances belonging to the chain are ten ſmall rods, each about two foot in length, ſhod and ſharp-pointed with iron, to ſtick in the ground at the end of every chain's length, when a length is meaſuring.

The manner of meaſuring a length is as follows.

1. One man takes an end of the chain in his hand, and walks towards the place he is to meaſure to, taking with him, under his arm, the aforeſaid ten ſticks.

2. When he has walk'd the length of the chain, the hindermoſt man cauſes him to move either to the right hand or to the left, &c. 'till he has placed him in a right line poſition from him, to the place to which they meaſure. Which being done, and the chain laid very ſtreight and tight, the foremoſt man ſticks down one of his ſticks and leaves it, and then walks on forward towards the mark he meaſures to, 'till the hindermoſt man comes up to the ſtick, the firſt ſtick'd down. And then (as aforeſaid) the hindermoſt man directs the foremoſt in a right line with the mark. Where after laying the chain ſtreight, he ſticks down a ſecond ſtick, and then walks forward towards the mark, and the perſon behind, alſo, bringing thoſe ſticks with him, as he takes them up at the end of every chain, 'till he comes to the next, and there repeats the ſame again, &c. and thereby he knows what number of chains is contain'd in that length ſo meaſured.

PROBLEM I.

PLATE XI.

Let it be required to make a plan of the field BDE FGHIKL, fig. XXI. plate XI.

1. Walk round the bounds of the ſame, and at every ſudden turn erect a ſtick, or ſtaff, of about five foot high, with a piece of white paper on the top of each, as at the ſeveral turns B, D, E, F, G, H, I, K, L.

2. Go into ſome convenient part of the field, from which you may ſee all the ſtation ſtaffs before erected, as at A, and there drive down a ſmall ſtake.

3. Meaſure from A to any one of the ſtation ſtaffs, as to L, and note down the chains and links contain'd therein, and alſo meaſure from L to K, and from K to A, and then you have the lengths of the three ſides of the triangle ALK, given.

4. By problem XIV. ſect. I. part I. make (or deſcribe) the triangle ALK, whoſe three ſides ſhall be equal to the aforeſaid three lines meaſured.

5. Meaſure and delineate the ſeveral offsets *m o*, *m o*, &c. by problem VI. ſect. I. part II. and deſcribe the crooked line L, *o*, *o*, *o*, *o*, *o*, *o*, K.

6. Meaſure from the ſtation ſtaff at K to I, and alſo from I to A, and then ſuppoſing A K to be a third given line, by problem XIV. ſect. I. part I. deſcribe the triangle A K I, and from the line K I ſet off the ſeveral offsets *m r*, *m r*, *m r*, &c. as aforeſaid, and delineate the crooked line K *r r r*, &c. I. Fig. XXI.

7. Meaſure from the ſtation ſtaff at I, to the next at H, and meaſure the diſtance I H, and from H to A, and ſuppoſing the line A I to be a third line, by problem XIV. ſect. I. part I. delineate the lines I H and H A, and by problem VI. ſect. I. part II. meaſure and ſet off the ſeveral offsets *m s*, *m s*, *m s*, &c. and trace the crooked line I *s s s s*, &c. H.

8. Proceed in the very ſame manner from H to G, and from thence to F, E, D, B and L, and thereby you will, with great eaſe, exactly deſcribe the plan, or figure of the field, as required.

☞ When you have ſeveral fields to ſurvey, then you muſt know how to place your ſtation in the ſecond field, after you have completed the firſt, which is to be performed as follows.

1. Go into the ſecond field, fig. XXII. and place your ſtation ſtaffs in convenient places about the ſame, as at N, O, P, Q, U, R, T and V.

2. In a convenient place, as at M, fix your ſtation as you did in the former field at A.

3. Meaſure from A to M and ſet down the meaſure, and alſo meaſure from L to M, and note that alſo. And then you have the length of two given lines. And if you ſuppoſe A L to be the third, then by problem XIV. ſect. I. part. I. deſcribe the lines A M and L M, interſecting each other in the point M, from which you may meaſure to every ſtation ſtaff, &c. and form that field, in the very ſame manner as the firſt, and the like rule from thence to X, fig. XXIII. and from that to others, &c.

N. B. When any incloſure is ſo ſituated, that you cannot go within ſide to make a plan thereof, as in the preceding, then you muſt go round the ſame without-ſide, and deſcribe the plan thereof as following.

1. Make

1. Make an eye-draught thereof (which is a rough draught on paper) wherein deſcribe every individual angle turning, &c.

2. Standing at any part thereof, as at *m*, conceive the line *m* A B, and from it meaſure the ſeveral offsets *l*, *l*, *l*, &c. and at their extreams draw the ſide of the field F E D, &c. according to problem VI. ſect. I. part II.

3. Standing at *m*, conceive the line *m g h*, and by prob. V. ſect. I. part II. meaſure the angle *m*, and note it down, and afterwards take the ſeveral offsets *o*, *o*, *o*, &c. as before, and then place yourſelf in another convenient place, as at *g h*, and there conceive the line *h i*, *g h*, and then proceed as before, and ſo from thence to other ſtations, 'till you have taken the whole circumference of the field; after which delineate the ſame from the eye-draught, by the rules before laid down, and thereby you will have an exact plan, as required, notwithſtanding you were not admitted within the ſame; which oftentimes happens by wood, water, &c. or when the land is a perſon's who will not allow a ſurveyor to go thereon.

If you conceive the aforeſaid figure (or at leaſt the circumference thereof) to be the ſide of ſo many ſtreets as incloſes that quantity of ground, you may, by the very ſame rule, delineate any pariſh, town, city, &c. provided that as you go on, you meaſure the offsets to the right hand ſide of the ſtreet as well as to the left, as the offsets *m r*, *m r*, &c. in the figure, and by their extreams deſcribe that ſide of the ſtreet, &c. alſo. But when the ſides of ſtreets are ſtreight lines, then there need none of theſe offsets, and the work is performed with much leſs trouble, and therefore I made choice of this moſt difficult part for an example.

Problem II.

Plate XII.

To make a plan or draught of any garden, wilderneſs, &c. and beautify the ſame with proper colours.

Let I K L M be a garden divided into walks, parterres, borders, &c. and 'tis required to draw a draught of the ſame, and to diſtinguiſh each particular with proper colours.

1. Draw the centeral line O N.

2. Meaſure the breadth of the middle walk B, and at the parallel diſtance of $\frac{1}{2}$ B C, draw the lines B F and C G, infinitely.

3. On

3. On any point of the centeral line as at O, draw the line P Q, at right angles infinitely, and at the parallel diſtance of P V (the breadth of the terrace) draw the line V K infinitely.

4. At the parallel diſtance of V O, draw the line O P, and divide that parallel diſtance with two other parallel lines in ſuch proportion as the ſlope and verges are divided.

5. At the diſtance of O A draw A D infinitely, as alſo the line E H at the parallel diſtance of A E, and likewiſe the lines XX and YY, at ſuch diſtances as their breadths contain. And thus have you, by thoſe parallel lines, divided the ſeveral croſs walks, &c. therein, in reſpect to their breadths. And to find their terminations, or interſections, proceed as follows.

1. On the lines A D and E H, from the points B C and F G, ſet off the meaſures B A, C D, E F, G H, and draw the lines A E and H D. Fig. XXIV.

2. The two parterres being thus encloſed, and their ſeveral parts being all parallel to each other, therefore meaſure the diſtances between the ſeveral lines contained therein, and draw every particular line parallel to the centeral line N O.

3. Give to every right line its particular length, and deſcribe every circular line by the rules laid down in ſect. II. part I. and thereby you will complete the ſeveral parts therein contained. And as the other outer walks, ſlopes, verges, &c. are all parallel to the aforeſaid, therefore at thoſe parallel diſtances, deſcribe every line, and thereby you will complete the whole draught, as required. And what is ſaid of the delineation of this, the ſame is to be underſtood of all others of the like nature. And, indeed, he that is well acquainted with all the preceding problems, is enabled to make a plan of this or any other garden without any more directions. And therefore it being needleſs to treat any further thereon, I ſhall leave the ingenious ſtudent to the practice thereof. And for his exerciſe I have ſubjoin'd the plan of a wilderneſs, fig. XXV plate XIII. wherein are contain'd ſome few artinatural lines, that may be worthy of his conſideration, and not a ſmall help to invention in deſigning gardens after that rural manner; which are not entirely new, but far preferable to the moſt regular ſet forms hitherto practiſed (as I obſerv'd before) in moſt parts of *England*, to the great diſadvantage of the proprietors, and ſhame of the pretended performers. And to demonſtrate more plainly, that the laying out of gardens has no ſort of recourſe to the exterior figure, or

bounds thereof, being regular, I have ſubjoined the plan, fig. XXVI. plate XII. wherein is delineated an artinatural walk, which demonſtrates that the moſt beautiful gardens are to be made in the moſt irregular forms or boundaries. Altho' the practice hitherto has been the reverſe. And thereby oftentimes to make a garden regular (*or rather totally ruin it*) the gentleman has been adviſed to purchaſe a part of his neighbours land at a very dear rate, purely for the ſake of regularity, which in all gardens ſhould be avoided, as may be ſeen in plate XIV. which is an entire garden according to the truth of deſigning, wherein you may behold art and nature in conjunction with each other, which in gardening is a general axiom to be obſerved, &c.

N B. To repreſent graſs you muſt uſe ſap-green, and gumbouge lightn'd for ſand or gravel.

Problem III.

Plate XV.

How to make the map of any eſtate, farm, lordſhip, mannor, &c. *Let it be required to make a map of the lands, fig.* XXVII.

1. By problem 7. ſect. I. part II. make a plan of the dwelling houſe B, and ſtable A.

2. By problem 5. ſect. I. part II. take the quantity of Fig. XXVII. the angle F, and draw the line F G.

3. Alſo take the quantity of the angle G, and draw the line G, *e*, equal to the meaſure taken, and by problem VII. ſect. I. part II. make the plan of the barn D and the ſtable E.

4. Take the angle H, and draw H I equal to its meaſure.

5. Take the angle I, and draw I N equal to its meaſure.

6. Meaſure the lines I, *o*, *o*, *o*, and *o*, N, and complete the trapezium I, *o*, *o*, N. So will *o*, *o*, be one end of the barn D E.

7. Meaſure either or both of the angles, *o*, and *o*, and complete the oblong plan of the barn D E, and alſo by the ſame rule complete the barn D I.

8. Meaſure the lines N K and L K, and delineate them. So ſhall you have completed the houſe, barns, ſtables, yards, &c.

9. In the field Z, in any convenient part, as at Z, drive down a ſtake for a ſtation.

10. Meaſure the lines V Z and T Z, and delineate them by the latter part of problem I. hereof.

11. Your

11. Your ſtation point being thus placed, meaſure from thence into every angle, or to ſuch ſudden turns in the hedges, as are remarkable, and then proceed in all reſpects as is laid down in problem I. hereof, and thereby you will exactly delineate a true map of the farm, as required.

Advertiſement.

I do hereby adviſe every gentleman, that when they imploy a land ſurveyor to meaſure and map an eſtate, they cauſe him to deſcribe every timber tree contain'd therein, and that the timber of every tree be meaſured, and the quantity of that meaſure written underneath each particular tree, with the firſt letter of the tree's name, as an E for elm, an O for oak, an A for aſh, &c. and thereby the true value of an eſtate, both of land and timber, may be known at all times, without any ſort of trouble. Alſo if a gentleman lets any land by leaſe, or otherwiſe, 'tis not in the power of his tenant to wrong him of any one tree of timber, contained in the lands to him demiſed, and many other excellent advantages too tedious here to mention.

Note, That when timber-trees ſtand ſo very thick (as in a wood) that the repreſentation of every tree, with its meaſure, cannot be inſerted, then at all ſuch times the ſurveyor muſt repreſent the baſis of every tree, by a point or period, with numerical figures to each, as 1, 2, 3, 4, 5, &c. Which numbers refer you to the very ſame numbers in a column placed on one ſide of the map, againſt which ſtands the true ſolid content of every tree, as each point, or figure repreſents. See L M of *Nuns* wood, with its tables of quantities, &c.

Problem IV.

Plate XVI.

How to increaſe or decreaſe any draught, at pleaſure.

Let *a b c d e f g h i k l m n o p*, &c. be a ſmall map of a farm, and 'tis required to increaſe the ſame four times its magnitude.

1. In any part of the ſame, as at A, make a point, and from that point, through all the ſeveral angles, draw right lines, and continue them infinitely. Fig. XXVIII.

2. Open your compaſſes from A, the given point, to *b*, and on the ſame line ſet that diſtance from *b* to B.

3. Make C *c* equal to A *c*, and draw the line B C.

4. Make D *d* equal to A *d*, and draw the line C D, and in the ſame manner, proceed 'till you have paſs'd through the whole, and thereby you'll encreaſe the map, as required.

Note, That by doubling the diſtance from the given point A to the ſeveral angles, you thereby (as aforeſaid) encreaſe the figure four times; therefore the double of that is eight times, and its half but two times, and conſequently its quarter but once. So that from theſe proportions you may increaſe, or decreaſe, any map to any proportion, as may be required.

Problem V.

Plate XVI.

How to deſcribe (and account for) the diminution of the breadths of long walks, avenues, viſto's, &c.

Fig. XXX. 'Tis obſervable, that the breadth of long walks, avenues, &c. appears to be much narrower at the further end, than at that end where the perſon ſtands, notwithſtanding the ſides of the walk are actually parallel to each other. But what is the reaſon thereof, no gardener, or indeed any other, has yet accounted for it to the publick. It is occaſion'd as follows,

1. All objects that appear equal in height, or breadth, are ſeen under equal angles; but when objects appear unequal, and are equal, ſuch objects are ſeen under unequal angles.

Demonſtration.

1. Let the lines C E G and A D F, repreſent the hedge lines of a walk, &c.

2. Draw the centeral line B Z, and let the points C, E, G, F, D, A, be remarkable places in the hedge lines C E G and F D A, and let the line W X V be drawn at right angles to Z B, as alſo the lines D E and A C.

3. Make T B equal to T X, and draw the lines C B and A B, as alſo W T and V T, as alſo E B and D B, and G B and F B.

4. The objects C A and V W, being equal to each other, and they lying placed at equal diſtances therefrom, as at T and B, are ſeen under equal angles, and do appear to be equal to each other; but the objects D E and F G, appear both leſs than V W or A C, by reaſon the angle E B D

and

and G B D, are both leſſer than the angle C B A, and from hence it appears, that the longer a walk is in looking from one end to the other, the more the viſual rays are contracted, and thereby conſtitute a leſſer angle, which is the real cauſe of the diminution of the walk, and is what was to be demonſtrated.

Note, That if in ſmall gardens where walks cannot be made of a great length, by contracting the further part to which a view is taking, 'twill make the walk appear to be of a greater length than it really is, and eſpecially when the contracted part aſcends the gentle aſcent of a hill, and the hedges planted with ſuch trees as produce leaves of a light green, as box, ſilver-holly, &c.

Problem VI.

How to deſcribe (and account for) the diminution of objects in a Land-skip.

This problem is no other ways differing from the preceding, than that the objects therein (*viz.* the breadth of the walk in its ſeveral parts) were horizontal, and here they are perpendicular.

Let it be required to draw the diminution of the trees R B, S C, T H, V I, W K and X L, as they appear at the point (or place) A.

1. From the point A to the points B, C, H, I, K, L, draw right lines, as the lines A B, A C, H A, A I, A K and A L.

2. From the vertical points of the trees, as the points B, C, H, I, K, L, let fall the perpendiculars B R, C S, H T, I V, K W, L X.

3. At D, where the line (or viſual ray) interſects B R, draw D M parallel to A X, ſo ſhall M S be the true diminiſhing height of C S. Fig. XXXI.

4. At E, where the line A H interſects B R, draw E N parallel to A X, ſo ſhall N T be the repreſenting, or diminiſhing height of H T, and the ſame of I V, K W and L X, and all others whatſoever.

And what is here ſaid in relation to the diminution of trees, the ſame is to be underſtood of buildings, animals, &c.

Problem VII.

How to give the exact height to any ſtatue placed on a building, that the ſame ſhall appear equal to the common height of a man ſtanding on the ground.

Let D C be the common height of a man (as five foot nine, or ten inches) and 'tis required to place a ſtatue on the building at I, ſhall that appear equal in height thereunto.

1. At any convenient place, as at A, upon the level of the building, place your ſtation, and draw the lines A C, A D and A I.

Fig XXXII. 2. On the point A, with any diſtance, deſcribe the arch B E F G, and make F G equal to E B, and draw the line A G H.

3. Continue C I to H, ſo ſhall I H be the height of the object, required.

Demonſtration.

The angle E A B is equal to G A F, therefore ſince H I is ſeen under the very ſame angle, as D C, by problem V. hereof, H I is in appearance equal to D C, and is the true height of that object, which is what was to be demonſtrated.

THE PRACTICE OF *Architecture, Gardening, Menſuration,* and *Land-Surveying,* Geometrically demonſtrated.

PART III.

Of Geometrical Axioms and Analogies, for the Menſuration of all Kind of Lines, ſuperficial Figures, and ſolid Bodies, &c.

Since the Menſuration of all Kind of Work is for the Generality perform'd by Croſs Multiplication, therefore I will firſt explain the ſame, and afterwards proceed to Menſuration in general.

SECT. I.

Of Croſs Multiplication.

LET it be required to multiply ſeven feet, three inches, ſix parts, by five feet, four inches, ſix parts.

	feet.	inch.	part.
Place the numbers thus	7	3	6
	5	4	6
1. Multiply 5 feet by 7, and the product is	35	0	0
2. Multiply the feet into the inches, as 5 into 3, which is 15, 12 of which make one foot, which place under the feet, and the remaining 3 under the inches.	1	3	0
3. Multiply the 7 feet into 4 inches, and the product is 28, wherein is twice 12, and 4 remaining, which is 2 feet and 4 inches, which place under feet and inches.	2	4	0
4. Multiply the inches into themſelves and their product is 12, which is 1 inch, which place under inches.	0	1	0
5. Multiply the parts into the feet, as 6 times 7 is 42, wherein 12 is contain'd thrice, and 6 remaining, which is 3 inches and 6 parts, which write under inches and parts.	0	3	6
6. Multiply the 6 parts into the 5 feet, and the product is 30, or 2 inches $\frac{1}{2}$, which alſo write down.	0	2	6
7. Multiply the parts into the inches, as 6 into 3, and the ſum is 18 parts, or 1 part and $\frac{1}{2}$, which write down under parts, as thus.	0	0	1 $\frac{1}{2}$
8. Multiply the 6 into 4, and the product is 24, or 2 parts, which alſo place under parts, thus.	0	0	2
Laſtly, Multiply the parts into themſelves, and their product is 36, of which 144 make 1 part, therefore 36 is	0	0	0 $\frac{1}{4}$
And the ſum is	39	2	3 $\frac{3}{4}$

SECT.

SECT. II.

Of Geometrical Axioms for the Menſuration of Lines and ſuperficial Figures.

PLATE XVII.

PROBLEM I.

To meaſure the geometrical ſquare ABCD, *whoſe ſides are each equal to* 16 *foot* 6 *inches.*

Rule.

Multiply any one ſide, as AB, 16 foot 6 inches, by any other of the ſides, as BD, and the product will be 272 foot 36 inches, the ſuperficial content required. Fig. I.

PROBLEM II.

To meaſure the parallelogram ABCD, *whoſe longeſt ſide is equal to* 28 *foot* 9 *inches, and its ſhorteſt to* 6 *foot* 6 *inches.*

Rule.

Multiply the length 28 foot 9 inches, by the breadth 6 foot 6 inches, and the product is 186 $\frac{12}{144}$ the ſuperficial content required. Fig. II.

PROBLEM III.

To meaſure the triangle NMO, *whoſe longeſt ſide* NO *is equal to* 42 *foot, and the perpendicular* MA to 16 *foot.*

☞ That before any right lined triangle is meaſured, a perpendicular line is let fall upon the longeſt ſide (or baſe) from the oppoſite angle.

Rule.

Multiply half the perpendicular (*viz.* 8.) by 42, the length of the baſe NO, and the product 336 is the ſuperficial content required. Fig. III.

PROBLEM IV.

To meaſure the trapezium OMNV.

Rule.

Fig. IV. 1. Draw the line M V, and then the trapezium is divided into two triangles.

2. Meaſure each triangle ſeverally, and the ſums together, and the total will be the ſuperficial content required.

Problem V.

To meaſure any irregular figure, as the figure L, O, V, R, S, N, M, I, D, E, W.

Rule.

Fig. V. 1. Divide the figure into triangles, and meaſure each triangle ſeverally, and note its quantity.

2. Add all the triangles together, and the total will be the ſuperficial content of the figure required.

Problem VI.

To meaſure any regular polygon, as a pentagon, hexagon, heptagon, octagon, nonagon, or decagon.

For the menſuration of all thoſe regular polygons, there is one general rule, *viz.*

Fig. VI. Multiply half the circumference, as E, O, M, I, by the radius or ſemidiameter A N, and the product will be equal to the ſuperficial content required. Or otherwiſe, you may divide the figure into triangles, and then meaſure each triangle, and add up the ſum total of the whole, and that ſhall be the ſuperficial content required.

Problem VII.

The ſide of a pentagon, &c. *as* B A *given, to find the ſemidiameter of a circle inſcribed therein.*

Rule.

Fig. XV. As 182 is to 125, ſo is the ſide of the polygon (be it any whatſoever) to the radius of the circle inſcribed therein.

Problem VIII.

To meaſure any circle, or ſection of a circle.

☞ The diameter of every circle hath ſuch proportion to its own circumference, as 7 hath to 22, or rather as 113 is to 355, therefore if any one be given, the other may thus befound. Rule

Rule I.

The diameter being given, to find the circumference.

Practice.

Multiply the diameter given by 22, and the product divide by 7, the quotient is the circumference required.

Rule II.

The circumference being given, to find the diameter.

Practice.

Multiply the circumference given by 7, and divide the product by 22, and the quotient is the diameter required.

Rule III.

The diameter of a circle being given, to find the area.

Practice.

1. Multiply the diameter into itſelf, and that product multiply by 11.
2. Divide the laſt product by 14, and the quotient is the area required.

Rule IV.

The circumference of a circle being given, to find the area.

Practice.

1. Multiply the circumference given, by itſelf, and the product alſo multiply by 7.
2. Divide the laſt product by 88, and the quotient will be the area required.

Rule V.

The circumference and diameter of a circle being given, to find the area.

Practice.

Multiply half the circumference by half the diameter, and the product will be the area required.

Rule VI.

The area of any circle being given, to find the diameter.

Practice.

Divide the area given by 11, and the quotient is the diameter required.

Or thus.

As 22, is to 28, ſo is the area to the diameter required.

Rule. VII.

The area of any circle being given, to find its circumference.

Practice.

As 7 is to 88,, ſo is the area to the ſquare of the circumference, whoſe root is the circumference required.

Rule VIII.

The area of any circle being given, to find the ſide of a ſquare equal thereunto.

Practice.

Extract the ſquare root of the area given, and the root ſhall be the ſide of the ſquare required.

Rule IX.

The diameter of any circle being given, to find the ſide of a ſquare, the content of which ſquare ſhall be equal to the ſuperficial content of the circle, whoſe diameter was given.

Practice.

As 7 is to 22, ſo is the ſquare of the radius to the area required.

Or thus.

As 113 is to 355, ſo is the ſquare of the radius to the area required.

Rule X.

The diameter and curve line of a ſemicircle being given, to find the content.

Practice.

Multiply $\frac{1}{2}$ the curve by the radius, and the product is the content required.

Rule

Rule XI.

The radius and curve line of a ſector of a circle being given, to find the content.

Practice.

Multiply the radius by $\frac{1}{2}$ the curve line, and the product is the content required.

Rule XII.

Any part, or ſegment, of a circle being given, as B C D L, *fig.* XVIII. *to find the area thereof.*

Practice.

1. By problem XI. ſect. II. part I. find the center E of the arch B C D, and draw the lines B E and D E, which will complete the quadrant E B C D.
2. By the laſt rule, meaſure the whole ſector E B D, and from it deduct the triangle EBD, and the remainder is the content of the ſegment required.

Problem IX.

To meaſure any ellipſis or oval form.

Rule.

Multiply the longeſt diameter by the ſhorteſt, and extract the ſquare root of the product, which ſquare root ſhall be the diameter of a circle equal to the ellipſis, which being given, you may by the preceding problem find the area required.

Problem X.

To meaſure the ſuperficies of a ſphere, or hemiſphere.

Rule.

The ſuperficies of a ſphere is equal to four great circles of that ſphere, therefore find the area of a circle, whoſe diameter is equal to the diameter of the ſphere given, and four times that area is the area of the ſphere required, and conſequently the half is the area of the hemiſphere alſo.

Or thus,

Multiply the diameter by the circumference, and the product ſhall be the ſuperficial content of the ſphere or globe. And if the axis only is given, the ſuperficial content may thus be found, *viz.* as 7 is to 22, ſo is the ſquare of the diameter to the content required.

Problem XI.

To meaſure the ſuperficial content of any cone.

Practice.

1. Find the ſuperficial content of the baſe by problem VIII. hereof.

2. Multiply the length contained between the vertex and the circumference of the baſe, by $\frac{1}{2}$ the circumference of the baſe, and to the product add the content of the baſe, and the total is the content required.

Problem XII.

To meaſure the ſuperficial content of any pyramis.

1. By the definition 33. ſect. I. part I. a pyramis is comprehended under divers flat ſuperficies, whoſe areas being found by the preceding problems and added together, their total will be the content required.

Problem XIII.

To find the ſuperficial content of a cylinder.

Practice.

1. Find the area of both ends by problem VIII. hereof, as alſo its circumference, which multiplied into the length, and the product added to the areas of both ends, their total is the content required.

Problem XIV.

To meaſure the ſuperficial content of any fragment or part of a globe, or ſphere.

Practice.

As the whole diameter of the globe is to the ſuperficial content of the globe, ſo is that part of the diameter belonging to the part, or fragment of the globe, to the ſuperficial content required.

SECT. III.

PLATE XVII.

Of Geometrical Axioms for the Menſuration of ſolid Bodies.

PROBLEM I.

To meaſure the ſolidity of a cube, as the cube ABCD, *whoſe ſide is equal to* 3 *foot.*

Proportion.

As 1 is to 3 the breadth, ſo is 3 to 9, and 9 to 27, the ſolidity required.

Or thus,

1. Multiply the ſide 3 by 3, the product is 9.
2. Multiply the laſt product 9 by 3 the depth, and the product will be 27, the ſolidity required.

☞ 'Tis to be obſerved that a parallelopipedon is but a long cube, and that the above rules, or proportions will meaſure the ſame, therefore an example is needleſs. See fig. X. Fig. IX.

PROBLEM II.

To meaſure a pyramis, as the pyramis MAON, *whoſe baſe is a geometrical ſquare, having each of its ſides equal to* 6, *and its altitude to* 12 *foot.*

Rule.

1. Find the area of the baſe. Fig. XI.
2. Multiply the area by $\frac{1}{3}$ of the altitude, and the product will be the ſolidity required. And as this is the rule by which a cone is alſo meaſured (as the cone, fig. XII.) therefore 'tis needleſs to add an example.

PROBLEM

Problem III.

To meaſure the fruſtum of a cone, or pyramis, as the fruſtum A *and* B, *in figures* XIII, *and* XIV.

Rule.

1. Find the area of each end of the fruſtum.

2. Multiply one area by the other, and extract the ſquare root of their product.

3. Add this ſquare root to the ſum of both areas, and their ſum multiply by $\frac{1}{3}$ of the fruſtum's length, and that product ſhall be the true ſolidity required.

☞ If you find the areas in inches, you muſt divide the ſolidity ſo found, by 1728, the number of cubical inches in a cubical foot, and the quotient will be the content in feet.

☞ I do adviſe the young ſtudent to be perfect in this problem, for hereon depends the whole truth of timber meaſuring, which hitherto has been kept in the dark, to the great injury of all gentlemen, who have diſpoſed of great quantities of timber according to the cuſtomary (tho' falſe and baſe) way of meaſuring.

Problem IV.

To meaſure the ſolidity of a ſphere, globe, or ball.

Fig. IX.

Suppoſe the diameter of a ſphere, globe, &c. be 12 inches, what is the ſolidity thereof?

Proportion.

As 21 is to 11, ſo is the cube of the diameter to the ſolidity required.

Or thus.

Cube the diameter, multiply by 11, and divide by 21. See the operation.

Fig. XI.

Diameter

Diameter	12	
	12	
Product	144	
	12	
	288	
	144	
	1728	**The diameter cubed.**
Multiply by	11	
	1728	
	1728	
Divide by	21)19008(905,	**ſolidity required.**
	189..	
	108	
	105	

$\frac{3}{21}$ **remains.**

Problem V.

The ſolidity of a ſphere being given, to find its diameter or axis.

Practice.

As 22 is to 42, ſo is the ſolidity to the axis or diameter required.

Problem VI.

A ſegment or portion of a ſphere being given, to find its axis.

Practice.

1. Multiply $\frac{1}{2}$ the chord of the ſegment, and divide the product by the height of the ſegment.

2. For the quotient add the height of the given portion, and the ſum is the axis required.

Problem VII.

To meaſure the ſolidity of a cylinder.

Rule

1. Find the ſuperficial content of one end.

2. Multiply the area ſo found by the length, and the product is the content required.

Problem VIII.

To meaſure the ſolidity of a priſm.

1. Find the ſuperficial content of one end.
2. Multiply the content ſo found, by the length, and the product is the ſolidity required.

Problem IX.

To meaſure the ſolidity of a mount, terrace walk, canal, &c.

Let A B C D E F repreſent the profile of a mount, terrace walk, &c. and 'tis required to meaſure the ſolidity thereof.

Rule.

1. The ſlopes A B E and C D F, are priſms, therefore meaſure thoſe parts according to the laſt problem.

Fig. XVI.

2. The body, or midſt B C E F, is a long cube. Therefore meaſure that part according to problem I. hereof.
3. Add both their quantities together, and the total ſhall be the ſolidity required.

☞ This kind of meaſure is always meaſured by the cubical yard (which by gardeners is called a load) and contains 27 cubical feet. Therefore if the dimenſions be taken in feet, the ſolidity muſt be divided by 27, and the quotient will be the ſolidity in yards.

The profile fig. XVII. is a repreſentation of the inſide of a canal, fiſh-pond, &c. and is meaſured by the very ſame rule as the above. Therefore to repeat the ſame again is needleſs.

Theſe three laſt ſections being duly conſider'd, and well underſtood (which may ſoon be done) the young ſtudent will thereby be enabled to meaſure the ſuperficial or ſolid content of any figure or body whatſoever. And ſeeing that the moſt difficult part of the menſuration of building, land, &c. conſiſts in the manner of taking the dimenſions, therefore that ſhall be the work of the next ſection, to which I proceed.

SECT.

SECT. IV.

Of the ſeveral Meaſures that Artificers work is accounted by, and the Manner of taking their Dimenſions.

I. Of Carpenters work.

1. THE principal work of carpenters is flooring, partitioning, and roofing, all which are meaſured by the ſquare, or 100 feet produced by 10 feet ſquared or multiplied into itſelf.

2. When you are to take the dimenſions of the frame of any timber floor, you muſt allow for the length of the joiſt laid in the walls, which is generally 9 or 10 inches.

3. When you meaſure flooring, without joiſt, the dimenſions are to be taken to the extreams thereof, out of which you muſt deduct the well-holes of the ſtair-caſe, and the chimney ways.

4. When you meaſure partitioning, you muſt deduct doors and door-caſes, and windows alſo, provided they are not to be included.

5. When you meaſure roofs, meaſure the length of the rafters by the length of the roof, and afterwards the hypps ſingly (inſtead of the common way, by allowing one and $\frac{1}{2}$ the ſuperficial content of the ground plot) without making any deductions for the holes of the chimney ſhafts, or vacancies, for sky or lanthorn lights, except 'tis agreed on otherwiſe.

6. Doors, ſhop-windows, &c. are meaſured by the ſquare foot, and alſo ſaſh frames, &c. ſtairs and ſtair-caſes are accounted for by the ſtep, in proportion to the nature and goodneſs of the work.

7. There be divers ſorts of work meaſured by running meaſure, *viz.* in length only; ſuch as cornices in general, pent-houſes, timber fronts, rails and balaſters, guttering, lintelling, ſkirting boards, breſtſomers, benching, ſhelving, &c.

II. Of Glaziers work.

Glaziers work is meaſured by the ſquare foot, and the dimenſions are taken in feet, inches, and parts, and the

moſt material things to be obſerved therein, are the following.

1. That in meaſuring of glazing in one building, there are many times windows of one magnitude, and at ſuch times you need meaſure but one, and thereby account for the others.

2. That ſemicircle, ovalar, &c. windows be meaſured, as ſquare windows, whoſe breadths, &c. are equal to their diameters; and the reaſon for ſo doing is, becauſe there is great waſte in cutting the glaſs, and much more time expended therein, than if the whole was a ſquare window.

III. Of Joiners work.

1. Joiners work is meaſured by the ſquare yard (of 9 feet) but their dimenſions are taken in feet and inches, and the product being divided by 9 (the ſquare feet in a yard) the quotient is yards.

2. In taking the dimenſions you muſt obſerve the following rules.

1. In taking the height of any corniſh, wainſcot, &c. that you meaſure with a line into, and about, every moulding, as is contained between the cieling and the floor, which you muſt call the height, or breadth, and the circumference of the room meaſured on the floor, the length, which being multiply'd as is taught in ſect. I. hereof, and divided by 9, the quotient is the content thereof.

2. When you meaſure window-ſhutters, doors, drawers, ſeats, or pews in churches, &c. you muſt account the meaſure $\frac{1}{2}$ as much more that it contains, in regard to its being worked on both ſides, and is what workmen call work and $\frac{1}{2}$ work.

3. That in meaſuring wainſcot you always deduct the doors, chimneys, and windows contained therein.

4. That you meaſure the window boards, ſaphetas, cheeks, skirt boards, &c. by themſelves. And,

Laſtly, When joiners make cornice and baſe, and ſubbaſe, &c. ſingly, they are meaſured by running meaſure, as alſo architrave and freize.

N. B. That chimney-pieces, frontiſpieces of doors, ornaments of windows, pediments, &c. are valued according to their goodneſs, at - - - *per* piece.

IV. Of Painters work.

1. Painters work is meaſured and taken as joiners, both in reſpect to girting about the moulding, as well as in meaſuring

meaſuring the length on the circumference of the floor, &c. and the deductions to be made are the ſame, but inſtead of accounting doors, window-ſhutters, &c. work and half work, they account it all whole work.

2. Window-lights, bars, caſements, &c. are done at - - - *per* piece, and oftentimes cantalivers, modillions, &c. and ornaments between them.

V. Of Plaſterers work.

Plaſterers works are principally of two kinds, *viz.* cieling work which is lathed and plaſtered, and rendering, which is alſo of two kinds, *viz.* rendering upon brickwalls free from quarters, &c. and rendering in partitions between quarters, which are all meaſured by yard meaſure, taken by feet and inches, and reduced into yards, as before delivered.

The principal things to be obſerved in taking the dimenſions are the following.

1. To deduct chimneys, windows, and doors.

2. To make no deductions (in rendering upon brick) for doors or windows, by reaſon the jaums and heads, generally exceed the dimenſions of the vacancies.

3. That ſuch ſommers and girders as lie below a cieling be deducted, if the workman find materials, otherwiſe not.

4. In rendering, when materials are found by the workman, to deduct $\frac{1}{4}$ for the quarters, but when workmanſhip only is found, no deduction muſt be made, for the workman could have rendered the whole as ſoon as if there had been no quarters there.

5. When you meaſure whiting and colouring between quarters, you muſt add a fourth or fifth part, for the returns or ſides of the quarters.

Laſtly, Ornaments in plaſter, as ornaments in cielings, capitals, architraves, freizes, cornices, &c. are meaſured by foot meaſure, in length only at - - - - *per* foot according to the goodneſs and nature of the work.

VI. Of Maſons work.

Maſons work is meaſured three different ways, as firſt, running meaſure, as the coping of walls, &c. Secondly, ſuperficial, as pavements, &c. And laſtly ſolid, as blocks of marble, &c. which ſeveral meaſures being all performed by the 3 firſt ſections hereof, I need ſay no more thereof, but that their dimenſions are taken in feet, inches and parts.

VII. Of Bricklayers work.

Of bricklayers work there are divers kinds, but the principal are walling, tyling, and paving.

1. Of walling, performed by the rod.

1. Of walls there are divers kinds, in reſpect to their length, height and thickneſs's, whoſe dimenſions are always taken in feet and inch meaſure in reſpect to length and height, and by the length of a brick, &c. in reſpect to their thickneſs.

2. The meaſure by which brickwalls are accounted is a ſquare rod or 16 feet 6 inches ſquared, whoſe product or quantity, is 272 feet ſquare and 36 inches, or $\frac{36}{144}$, whoſe $\frac{1}{2}$ is 136 feet $\frac{18}{144}$ and quarter 68 feet $\frac{9}{144}$.

3. The manner of meaſuring brick walls is the very ſame as any other ſuperficial meaſure, provided their thickneſs be exactly the ſtandard thickneſs, *viz.* one brick and $\frac{1}{2}$ and the product of the dimenſions divided by 272: 26, whereby the number of ſquare rods contained therein may be known.

4. When the thickneſs of brickwalls exceeds or is leſs than the ſtandard thickneſs of one brick and half, they muſt be reduced thereunto by this general rule.

Multiply the ſuperficial content of the wall by the number of half bricks contained in the thickneſs, and divide the product by three (the number of $\frac{1}{2}$ bricks contained in the ſtandard thickneſs of one brick and $\frac{1}{2}$) and the quotient ſhall be the true content of the wall, reduced to the ſtandard thickneſs of one brick and half, as required.

5. When brickwalls are of divers thickneſs they muſt be ſeveraly taken, and their ſeveral quantities being added together will be the content of the whole, as required. And here note, that whatſoever doors, windows, &c. are contained in the ſeveral thickneſſes of ſuch walls, that you deduct them out of the total product of the reſpective dimenſions or thickneſs, wherein they are ſituate, and the remainder will be the true content of the work.

6. When you are to meaſure walls that meet, and conſtitute an angle, you muſt take the length of one wall to the out-ſide of the angle, and the other to the inſide.

7. When you have any chimneys to meaſure, meaſure them as a ſolid, and deduct the vacancies, (as taught by *Venterus Mandey* in his appendix of *chimneys reformed* in his *Mellificium Menſionis*) and thereby you will have the

the true ſolidity; but if you practice the common way of girting chimneys, you never can have the true content, and will always remain in the dark, as many ſtubborn ignorant conceited fools now are.

2. Of walling, performed by foot meaſure.

1. This part of walling is that which is called ornament, ſuch as arches over doors, windows, &c. *Facio's*, architraves of doors, windows, &c. freizes, cornices, ruſtick cones, rubbed returns, &c. and in ſhort all kind of work performed in a rubbing houſe with ax and ſtone is ornamental work, and is always performed at ---- *per* foot.

2. When you have any of theſe ornaments to meaſure, that have unequal ſides, as the arch over a window, &c. you muſt take the dimenſion thereof in the middle and thereby 'twill be a mean. And beſides the aforeſaid ornaments which are performed by foot meaſure, there are divers other ornaments that are performed --*per* piece, and ſuch are peers, columns, pillaſters, architraves, freizes, cornices, grottos, caſcades, pediments, &c. which are valued according to the nature and goodneſs of the materials and workmanſhip.

3. Of tyling.

1. As carpenters meaſure their roofs by the ſquare of 10 feet (*viz.* 100) ſo alſo do bricklayers their tyling, whoſe dimenſions are always taken in feet and inch meaſure, and their products being divided by 100 (the number of ſquare feet in a ſquare) the quotient is the content required.

2. When you take the dimenſion of a roof, you muſt firſt meaſure the whole length, as far as the tiles are laid, for your length, and from the ridge to the eves for the depth, and thereby the quantity of tyling will exceed the quantity of roofing, by ſo much as the tyles go beyond the roof at each end, and over the eves board.

3. It often happens, that in ſome roofs there are many hips and valleys, which muſt be paid for, at ---- *per* foot running meaſure.

N. B. That what is here ſaid of tyling, the ſame is be underſtood of ſlating.

4. Of paving.

Since it often happens that cellars, kitchins, grottos, &c. are paved by bricklayers, therefore I thought it neceſſary to mention it here, at the concluſion hereof, where-

in you are to underſtand, that the dimenſions of ſuch work are taken in feet and inch meaſure, and the content is always given in ſquare yard meaſure, as plaſtering, rendering, &c.

SECT. V.

Of the Manner of caſting up the Dimenſions of Land Meaſure taken with Gunter's *Chain (which of all others is the beſt.)*

PROBLEM I.

Suppoſe an oblong piece of land contain 15 *chains* 25 *links in length, and* 13 *chains* 75 *links in breadth, what is the content?*

Rule.

1. Multiply 15 : 25, by 13 : 75, according to the common way of vulgar multiplication, and the product will be 20,96875, from which cut off the five laſt figures towards the right hand, *viz.* 96875, and the remainder to the left, *viz.* 20, is the number of acres.

2. Multiply the five figures cut off by 4 (the number of roods in an acre) and the product will be 387500, from which cut off five figures, as before, and the remaining is roods.

3. Multiply thoſe figures laſt cut off by 40 (the number of ſquare poles in a rood) and the product is 3500000, from which cut off five figures, as before, and the remainder is poles.

Laſtly, If any numbers remain in the laſt five figures cut off, multiply them by $272\frac{1}{4}$, and cut off five figures, as before, and the remainders to the left, ſhall be the odd feet, which in land meaſure is exact enough. See the operation.

Length

Length	15:25	
Breadth	13:75	
	7625	
	10675	
	4575	
	1525	
Acres	20)96875	Theſe five figures
Multiply by	4	The roods in an acre.
Rods	3)87500	Theſe five figures
Multiply by	40	The poles in a rod.
Poles	35)00000	

Problem II.

Plate XVII.

The plan of a piece of land with the area given, to find the ſcale by which it was plotted, ſuppoſing ſuch a ſcale was left.

Suppoſe A B, C D, to be a plan, equal in area to 34 acres 31 centeſims, I demand by what ſcale the figure was plan'd.

1. If you meaſure the ſide A B with a ſcale of 10 in an inch, the length A B will contain 38 chains and 12 centeſims, and the breadth A C 6 chains and 25 centeſims. The content will be found to be 23 acres and 82 parts. Wherefore if you divide the diſtance on the ſcale of logarithms between 23: 82, and 34: 31 into two equal parts, and ſetting one foot of your compaſſes upon 10, the imagin'd ſcale, the other will reach to 12, which is the ſcale required. Fig. VII.

Problem III.

Of the menſuration of turf, with which graſs walks, plotts, &c. are made. The turf uſed in theſe works, is the fineſt that can be had, from commons, heaths, &c. which are generally cut at one ſhilling per 100, every turf being one foot in breadth and three foot in length. Therefore to find what quantity of turf will cover any walk, &c. find how many ſquare feet are contain'd therein, and divide that number by 3, the number of feet in a turf, and the quotient will be the number of turf required. As for example,

There is a walk to be turf'd, whoſe length is 100 foot, and breadth 16 feet, how many three foot turf will cover the ſame, ſuppoſing no waſte to be made?

The length	100	
The breadth	16	
Product	1600	Which divide by 3, as follows.
3	1600	$533\frac{1}{3}$ the number of turf re-
	15	(quired.
	10	
	9	
	10	
	9	
	1	remains.

Note, That this calculation ſuppoſes no waſte to be made, which in laying them is impoſſible. Therefore the uſual allowance for waſte is as follows, *viz.* a hundred of turf, which contains 300 foot, is allowed to completely finiſh one rod of ground, which contains $272\frac{1}{4}$ feet.

SECT. VI.

Of divers Analogies, or Proportions, in Land Meaſure.

Proportion I.

Having the length and breadth of an oblong given in chains, to find the contents in acres.

As 10 is to the breadth in chains, ſo is the length in chains to the content in acres.

Proportion II.

Having the perpendicular and baſe of a triangle given in perches, to find the content in acres.

As 320 is to the perpendicular, ſo is the baſe to the content in acres.

Proportion

Proportion III.

Having the perpendicular and baſe of a triangle given in chains, to find the content in acres.

As 20 is to the perpendicular, ſo is the baſe to the content in acres.

Proportion IV.

Having the content of a ſuperficies in one kind of meaſure, to find the content of the ſame ſuperficies, according to any kind of perch meaſure.

As the length of the ſecond perch is to the length of the firſt perch, ſo is the content in acres to a fourth number, and the fourth number to the content in acres required.

Proportion V.

Having the length and breadth of an oblong ſuperficies given in perches, to find the content in acres.

As 160 is to the breadth in chains, ſo is the length in perches to the content in acres.

Proportion VI.

Having the length of a ſuperficies in chains, to find the breadth of an acre.

As the length in chains is to ten, ſo is one acre to the breadth in chain meaſure.

THE

PRACTICE

OF

Architecture, *Gardening*, *Menſuration*, and *Land-Surveying*, Geometrically demonſtrated.

PART IV.

Containing divers excellent Tables of Menſuration, which ſhew, by inſpection, the true ſuperficial, or ſolid Content, of any Kind of Meaſure, according to any Dimenſions given.

SECT. I.

Of Engliſh *Meaſures uſed in Lands and Buildings.*

BEFORE I begin the tables, 'twill not be improper to inſert the following meaſures, *viz.* That

A ſquare foot	Contains	144 ſquare inches.
A cubical foot		1728 cubical inches.
A ſquare yard		9 ſquare feet.
A cubical yard		27 cubical feet.

A ſquare	Contains	100 ſquare feet, or 10 foot every way.
A load of timber		50 foot cubical.
A load of planks 2 inches thick.		300 ſquare feet.
		200 ſquare feet.
		150 ſquare feet.
		400 ſquare feet.
		600 ſquare feet.
A geometrical pace		5 feet in length.
A geometrical perch		10 feet in length.
A ſtatute pole or perch		16 feet ½ in length.
A ſquare ſtatute perch		272¼ ſquare feet.
A woodland pole or perch		18 foot in length.
A ſquare woodland pole		324 ſquare feet.
A forreſt pole or perch		21 foot in length.
A ſquare forreſt pole		441 ſquare feet.
4 ſtatute perches		One chain length.
10 chains length		A furlong or acre's length.
4 chains length		An acre's breadth.
40 ſquare perches		A rood or ¼ acre.
4 rood, or 160 perches		An acre.
A hide of land		100 acres

Bricks according to the ſtatute, ſhould be 9 inches in length, 4 inches ½ in breadth, and 2 inches ½ in thickneſs; 500 is a load. Plain tile, in length 10 inches ½, breadth 6 inches ¼, and thickneſs ¾ inch; 1000 is a load. Gutter tile in length 10 inches ½, the breadth and thickneſs in proportion. Roof tile in length 13 inches, thickneſs ½ inch and ½ quarter, the depth proportional. Lath 5 ſcore to the bundle, when 5 foot long; but when 4 foot in length, then 6 ſcore to the bundle. Deals and nails 120 to the hundred. Lime is ſold by the bag, which ſhould be a buſhel, 25 bags is called a hundred; 'tis in ſome places ſold by the load, which is about 40 buſhels. A tun of iron is 2240 pound weight; and a fodder of lead 19 hundred ½, or 2184 pound.

SECT. II.

Of the Explication of the Inſpectional Tables of Menſuration.

Table I.

THis table is deſign'd for ſmall menſurations, as painting laid with leaf gold, which is generally done for 5*s.* *per* foot, if plain without carving; and if carved, double the price, by reaſon a great quantity of gold is waſted in gilding the broken parts of the ſame and glazing, &c. which is coſtly work, and ſeldom is in great quantity together.

The uſe of this table is as follows.

Suppoſe a piece of gilding, glazing marble, &c. *be* 11 *inches in breadth, what length muſt be taken for a ſquare foot?*

Practice.

1. In the firſt column (entitled the dimenſions breadth in inches) find 11 (the breadth of the work) and againſt it ſtands 1, 1, 1, which ſignifies one foot, one inch, and one tenth part of an inch, and is the length required to make one ſquare foot.

2. To find the content of the whole, open a pair of compaſſes to the extent of 1 foot, 1 inch, and $\frac{1}{10}$, and run that extent through the whole length of the dimenſions, and the number of thoſe extents ſhall be the number of feet required.

Example 2.

Suppoſe a ſlabe of marble is 13 *foot* 4 *inches and* $\frac{2}{10}$ *of an inch in length, and* 23 *inches wide at one end, and* 17 *at the other, what length muſt be taken for a ſquare foot, and how many doth it contain?*

Practice.

1. Add the ends together 23 and 17, and take a mean, *viz.* 20.

2. A-

2. Againſt 20 in the firſt column ſtands 0, 7, 2, *viz.* ſeven inches and $\frac{2}{10}$ of an inch, which is the length of a foot required.

And if the compaſſes be opened to that extent, 'twill paſs through the ſame exactly 22 times, which is the number of feet contain'd therein.

Note, That what is ſaid here in relation to the menſuration of marble, the ſame is to be underſtood in any other kind of meaſure.

Table II.

This table is calculated for any large menſurations of ſuperficial feet meaſure, and is divided into 21 columns. The firſt contains the dimenſions breadth in inches from 1 to 36. The other 20 columns, contains the dimenſions length in feet. Every of theſe columns is number'd at their heads from 1 to 20 feet, as 1 foot, 2 feet, &c. and under every of theſe numbers in each column, is placed the letters F P, which denote feet and part of feet. And here you are to obſerve, that every ſquare foot is divided into 100 equal parts, and thoſe parts, or numbers written under the letter P in every column, are ſo many parts of a hundred or foot. Therefore 25 of thoſe parts is a quarter, 50 a half, and 75 three quarters of a foot, and the like of any other centeſimal part.

Uſe.

Suppoſe a ſlabe of marble be 22 inches in breadth and 11 foot in length, what's the content?

In the angle of meeting of 22 (accounted from the ſide or firſt column,) and 11 (accounted from the head) is 20: 16, which is 20 ſquare foot and $\frac{16}{100}$ the content required.

Example 2.

There is a marble pavement 12 foot in breadth and 17 foot in length.

☞ When the breadth happens to be greater than 36 inches, as herein, you muſt firſt work, ſuppoſing the breadth was 36 inches only, and note that content.

2. As often as you can find 36 in the breadth, ſo many times add the firſt content (as in this example is 4 times) and if any part of the breadth remain, proceed as at firſt, and add that to the ſum of the ſeveral additions and the ſum ſhall be the content required. I need not add the operation, by reaſon 'tis ſo very eaſy and plain.

When meaſures happen unequal at each end, add them together and take a mean, as in table I.

Tables III, and IV.

Theſe two tables are both calculated for the menſuration of ſolids, as timber, ſtone, &c. as are truly ſquare at their ends.

Uſe of table I.

There is a piece of ſquare timber, whoſe ſides are each equal to 13 *inches, what length muſt be taken for one ſolid foot ?*

Practice.

Againſt 13 in the firſt column, ſtands 0, 10, 2, *viz.* 10 inches and 2 tenths of an inch, which is the length required.

Table II.

Suppoſe a piece of timber be 16 *inches ſquare at each end, and* 37 *foot in length, what is the content?*

Note, That as this table is calculated but to ten foot in length, therefore find the quantity of 10 foot in length firſt, and then treble it, and afterwards find the quantity of 7 foot in length, and add that to the former, and the ſum ſhall be the ſolid content required.

Practice.

1. Againſt 16 in the firſt column, under 10 feet at the head, ſtands 17 : 78, which is 17 ſolid foot, and 78 parts of a hundred.

2. Ten being contain'd 3 times in 37, therefore treble 17 : 78, and the ſum will be 53 : 34.

3. For the quantity of the odd 7 foot, look under 7 foot at the head, againſt 16 of the ſide, and in that angle of meeting ſtands 12 : 44, which added to the former 53 : 34, is equal to 65 : 78, *viz.* 65 foot and 78 parts, which is $\frac{78}{100}$ more than 3 quarters of a foot, and is the ſolid content required.

Note, That what is ſaid in this example, the ſame is to be underſtood in all others of this nature. And becauſe 'tis ſeldom that timber, or ſtone, happens exactly ſquare at their ends; therefore I have here ſubjoin'd a table of mean proportionals, by the help of which any unequal ſided timber may be meaſured by this table, as in the above example.

Table

Table V.

This table of mean proportionals, is calculated on purpoſe to reduce unequal ſided timber, &c. to exact ſquare meaſure, and thereby the laſt table is made capable to meaſure any kind of four ſided timber whatſoever.

Uſe.

Suppoſe one ſide of a piece of timber be 19 *inches, and the other* 7 *inches, what is the mean proportional, or what is the length of the ſide of a ſquare equal thereunto?*

Practice.

1. Againſt 7 in the firſt column ſtands 084509, and againſt 19 ſtands 127875.

2. Add thoſe 2 numbers of the ſecond column into one ſum, and 'twill be equal to 212384.

3. Divide this laſt number into 2 equal parts, then will the half be 106192.

4. Look for this number (or the neareſt to it). in the table which is 107918, againſt which ſtands 12, which is the length of the ſide of a ſquare equal thereunto, as required.

The ſide of the ſquare being thus found, enter the laſt table therewith, with any length aſſign'd, and proceed as therein directed (which is very plain and familiar, and the ſolid content will be found, as required. But to make it fully plain, take this example.

Let the length be 9 *foot.*

Firſt, Look for 12 inches in the firſt column, and under 9 foot (at the head of the table) ſtands 9 : 0, *viz.* 9 foot, 0 inches, which is the ſolid content required.

Table VI.

The abſolute reaſon of the conſtruction of this table, is to ſhew the great error and deceit as is contain'd in the cuſtomary way of meaſuring timber, and to prevent the practice thereof for the future.

The manner of uſing this table is exactly the ſame as the firſt and third. The column, wherein the words, the girt, &c. are inſerted, is numbered from 10 to 100. The other column contains the feet, inches, and tenth parts of an inch, as will make a ſolid foot in length at every circumference of the firſt column.

Example.

There is a piece of round timber that in the middle is 52 inches girt (or circumference) and 40 foot in the length, what's the ſolid content?

Practice.

1. In the firſt column find 52 the girt given, and againſt it ſtands 0, 8, 0, which is 0 feet, 8 inches, and 0 parts, and is the length of a ſolid foot, at that girt.

2. Take the diſtance of 8 inches in your compaſſes, and run them along the piece of timber in a right line, and as often as that diſtance is found therein, ſo many ſolid feet is contain'd in that piece of timber, which in this example is 60 times, and therefore the ſolidity is 60 foot, or one load and ten foot.

Now for a demonſtration of the aforeſaid error and deceit in the cuſtomary way of meaſuring, I'll meaſure the aforeſaid piece of timber, according to the common way, which is to double the ſtring by which the girt is taken 4 times, or to take $\frac{1}{4}$ of the girt for the ſide of a ſquare, and then meaſure the ſame as ſquare timber, as follows.

1. The aforeſaid girt is 52, one fourth thereof is 13. The ſide of a ſquare (which they ſuppoſe to be, or at leaſt ſay is true, tho' infinitely from it.)

2. The piece of timber being 40 long (and the fourth table hereof being calculated but to 10 foot length) therefore meaſure one fourth only, and quadruple it, ſo ſhall the mult be the content required. As for example.

Againſt 13, the ſide of the ſquare, and under 10 foot at the head of the table, ſtands 11 : 74, the ſolid content of 10 feet in length, which quadrupled is equal to 46 feet and 96 hundred parts, which is almoſt 47 feet.

From hence it appears, that the true content by the firſt (and true) way, is 60 feet complete, and by this way not quite 47 feet. Therefore 'tis 13 feet too little, or leſs than the true quantity.

Now ſuppoſe the aforeſaid piece of timber was oak, which is never ſold for leſs than one ſhilling per *foot, then will the aforeſaid loſs of* 13 *feet be* 13 *ſhillings at leaſt.* Therefore,

If in 60 foot there is but 47 foot accounted for, in 50 foot there is but $39\frac{1}{6}$ foot accounted for, and in every 50 foot, or load of timber, there is almoſt 11 foot of timber loſt, which, as before, is worth at leaſt eleven ſhillings.

Now if in one load of timber eleven ſhillings is loſt, what in a hundred? Anſwer, 55 pound.

So that from what I have here delivered, 'tis evident, that all ſuch gentlemen as have ſold large quantities of timber, by the common way of meaſuring, have been actually cheated of $\frac{1}{5}$ of the ſame. But as I have taken the pains here, not only to demonſtrate the ſame, but alſo to lay down eaſy plain rules and tables, 'tis hoped that the ſame will put a final end to all ſuch impoſtors dealings.

Table VII.

This table is calculated as well for the uſe of the farmer, &c. to divide and lay out his corn-lands, meadows, &c. as for a gentleman to meaſure and let, diſpoſe, purchaſe, &c. when a ſurveyor is not to be had eaſily, &c.

This table is of 4 parts, each part being divided into 5 columns, and every column into two others. That of the firſt, entituled, the breadth of the land, hath two rows of figures, thoſe to the left are poles or perches, and thoſe to the right hand are quarters or fourth parts of a pole or perch, and are diſtinguiſhed at the head, by the words perch and $\frac{1}{4}$ parts.

The other columns have at their heads the words 1 rood, 2 rood, 3 rood and one acre, and underneath thoſe words the letters P. pts. &c. the letter P in every column ſignifies perch, and the letters pts. hundred parts of a pole or perch.

☞ I do adviſe the practitioner to have a $\frac{1}{2}$ pole or pearch, divided into 5 equal parts, and one of thoſe parts ſubdivided into ten equal parts, ſo will the whole be in effect divided into 50 parts, and will be anſwerable to the hundred parts of a perch, as is expreſs'd in the table. Theſe diviſions are beſt repreſented by broad-headed nails, with the number of the diviſion engraved on the head of each nail.

The uſe of this table is as follows.

Suppoſe a piece of land be 7 poles in breadth, how much in length will make one rood, two rood, or an acre?

Practice.

Againſt 7 poles in the firſt column, ſtands in the ſecond 5 perch 76 parts, the length of one rood, and in the ſecond 11 perch 42 parts the length of two roods, and in the

the third 17 perches, 28 parts, and in the fourth 22 perches 85 parts, the length of an acre required. So alſo had the breadth of the land been 7 poles and 1 quarter, then would the ſeveral lengths be as follows, *viz.*

		Perch.	Parts.	
The length of	1 rood	5	52	And the like of any other breadth.
	2 rood	11	4	
	3 rood	16	56	
	Acre	22	8	

By the example laſt mention'd it appears, that as often as 22 perches and 8 hundred parts is contain'd in the length of any field, as is 7 poles and $\frac{1}{4}$ in breadth, ſo many acres is contain'd therein, and if at laſt any length is remaining as is leſs than an acre, meaſure off ſuch a length, as that for 3 roods, 2 roods, or 1 rood, &c. as you find will be contain'd therein, and thereby you may have the true quantity to leſs than $\frac{1}{4}$ of an acre. And to find the true meaſure of the remaining part as is leſs than one rood, divide the ſpace of 5 perch 52 parts, into 40 equal parts, and as many of thoſe parts as are contain'd in the remaining part, is the number of odd perches, and thereby you have the whole content, in acres, rood, and perches, as land is generally meaſured.

A very little practice will make this very plain and familiar, and therefore I recommend you to the ſame, during which I ſhall imploy my pen in other important parts of architecture and gardening which I ſhall communicate in another treatiſe very ſpeedily for publick benefit.

MVSEVM BRITAN NICVM

S.

Fig: XLV.

Fig: XLVII.

Fig: XLVI.

Fig: XLVIII.

Fig: XLIX.

Fig: L.

Fig: LI.

Fig: XXXVIII.

Fig: XL.

Fig: XLI.

Fig: XLII.

Fig: XLIII.

Fig: XLIV.

Fig: XXXI.

Fig: XXXII.

Fig: XXXIII.

Fig: XXXIV.

Fig: XXXV.

Fig: XXXVI.

Fig: XXXVII.

Fig: XXIV.

Fig: XXV.

Fig: XXVI.

Fig: XXVII.

Fig: XXVIII.

Fig: XXIX.

Fig: XXX.

Fig: XVII.

Fig: XVIII.

Fig: XX.

Fig: XIX.

Fig: XXI.

Fig: XXII.

Fig: XXIII.

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Fig: I.

Fig: II.

Fig: III.

Fig: IV.

Fig: V.

Hyperbolical Parabolical Hyperbola

Fig: VI.

Fig: VII.

Fig: VIII.

Fig: IX.

Fig: X.

Fig: XI.

Fig: XII.

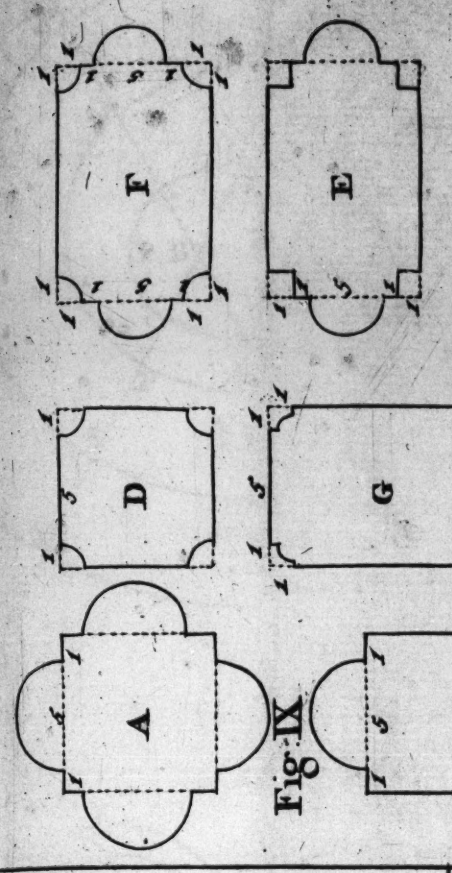
Fig: XIII.

Fig: XV.

Plate I

Fig: XIV.

Fig: XVI.



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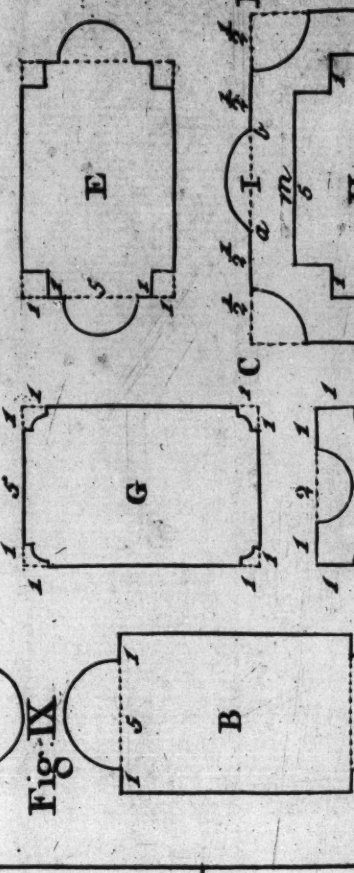

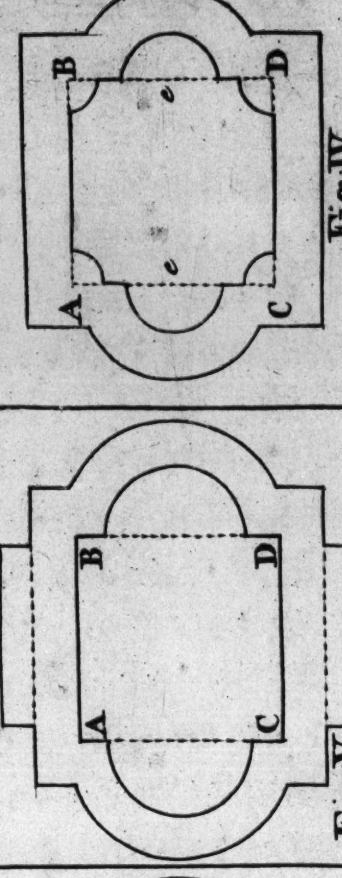

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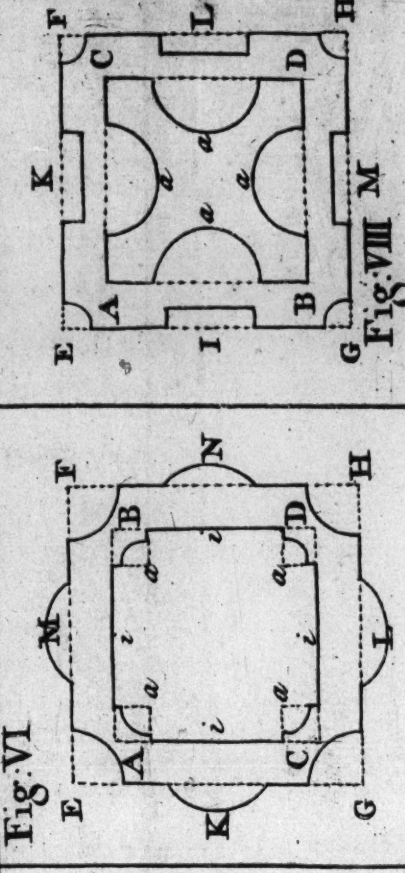
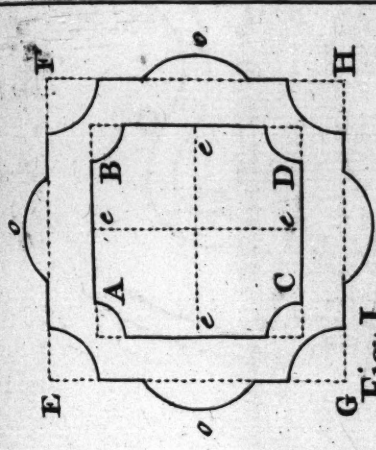


Fig: VIII

Fig: V

Fig: VI



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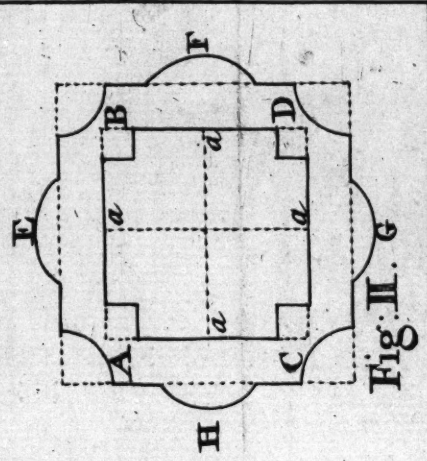

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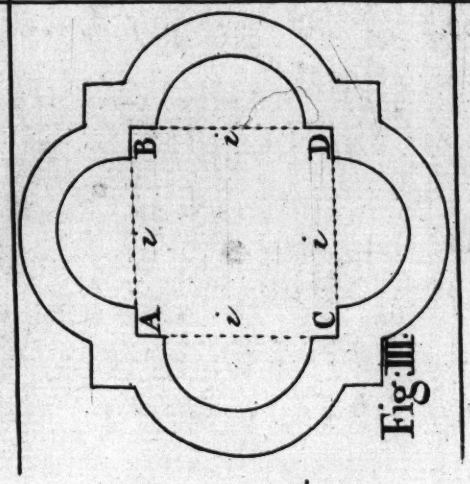

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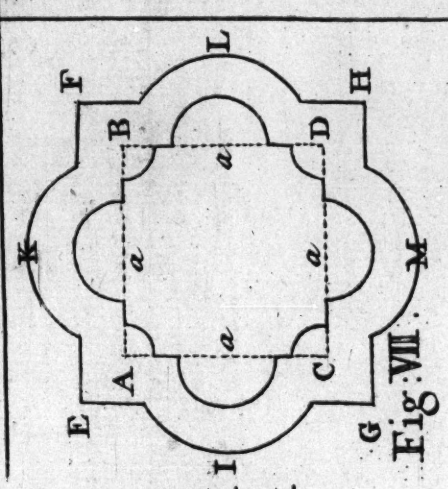

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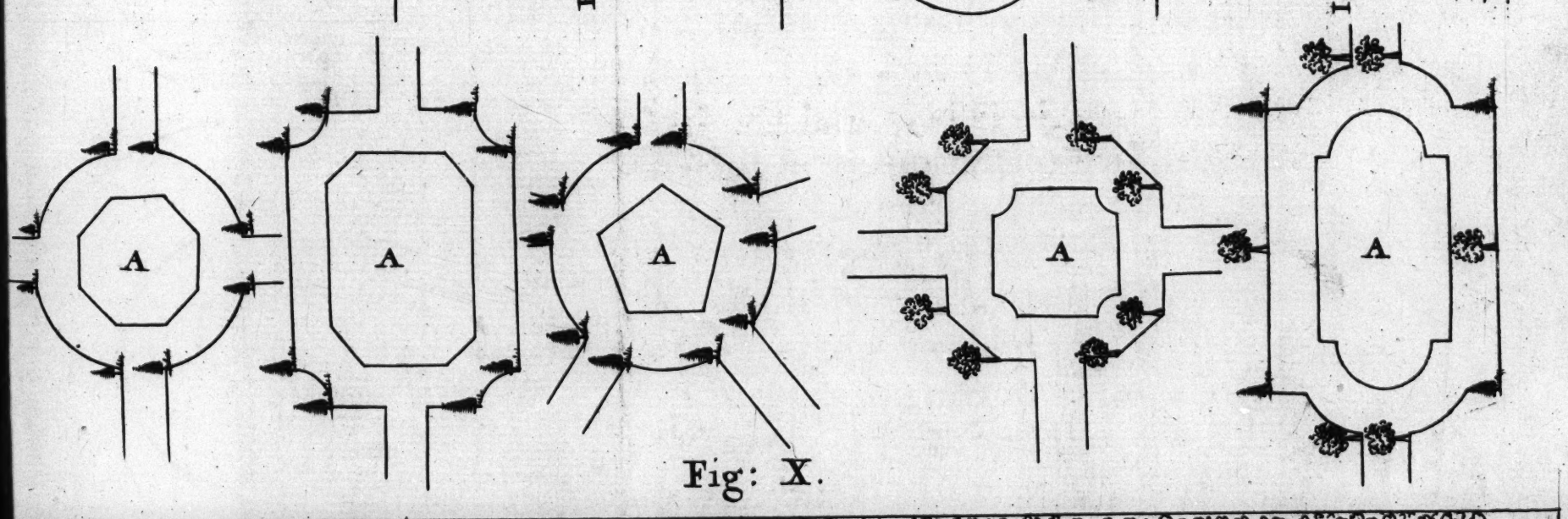

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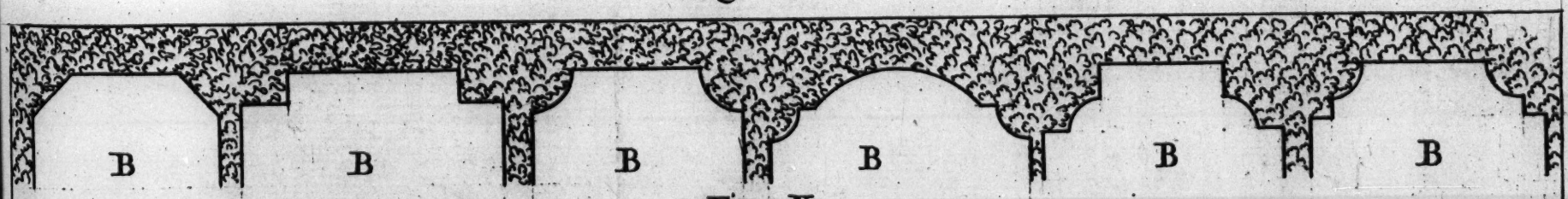

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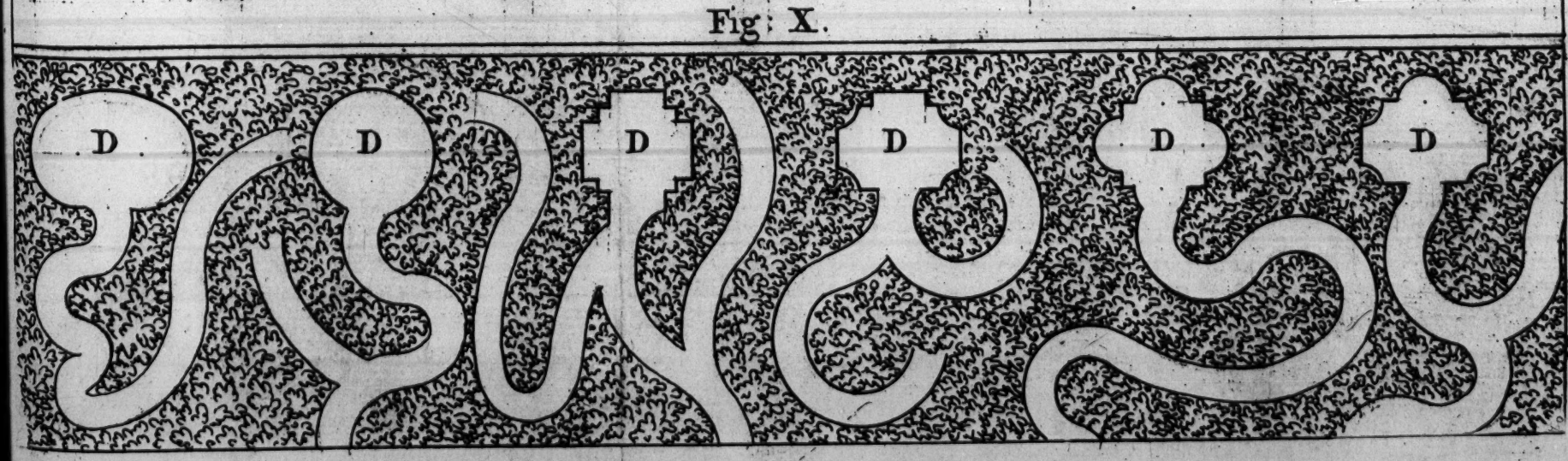

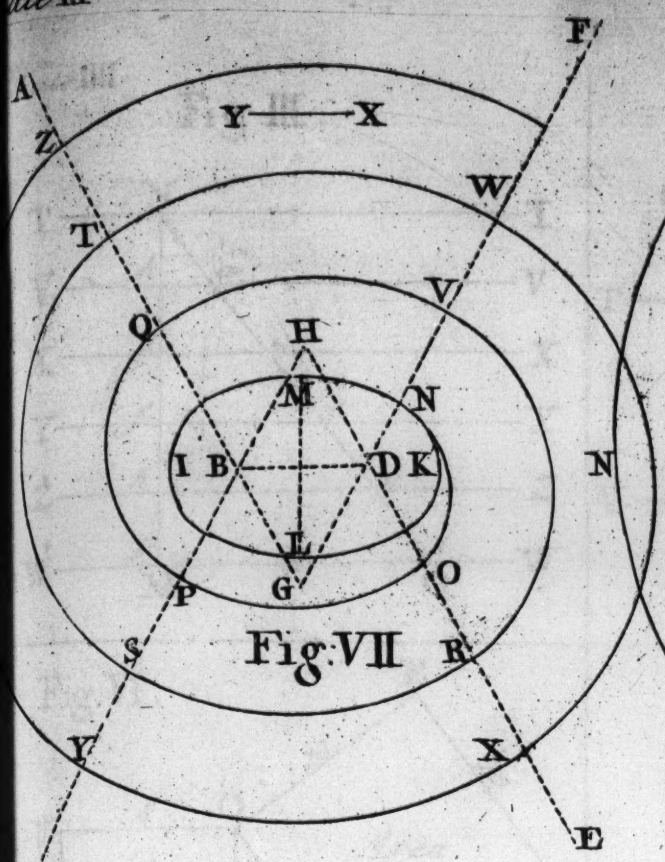

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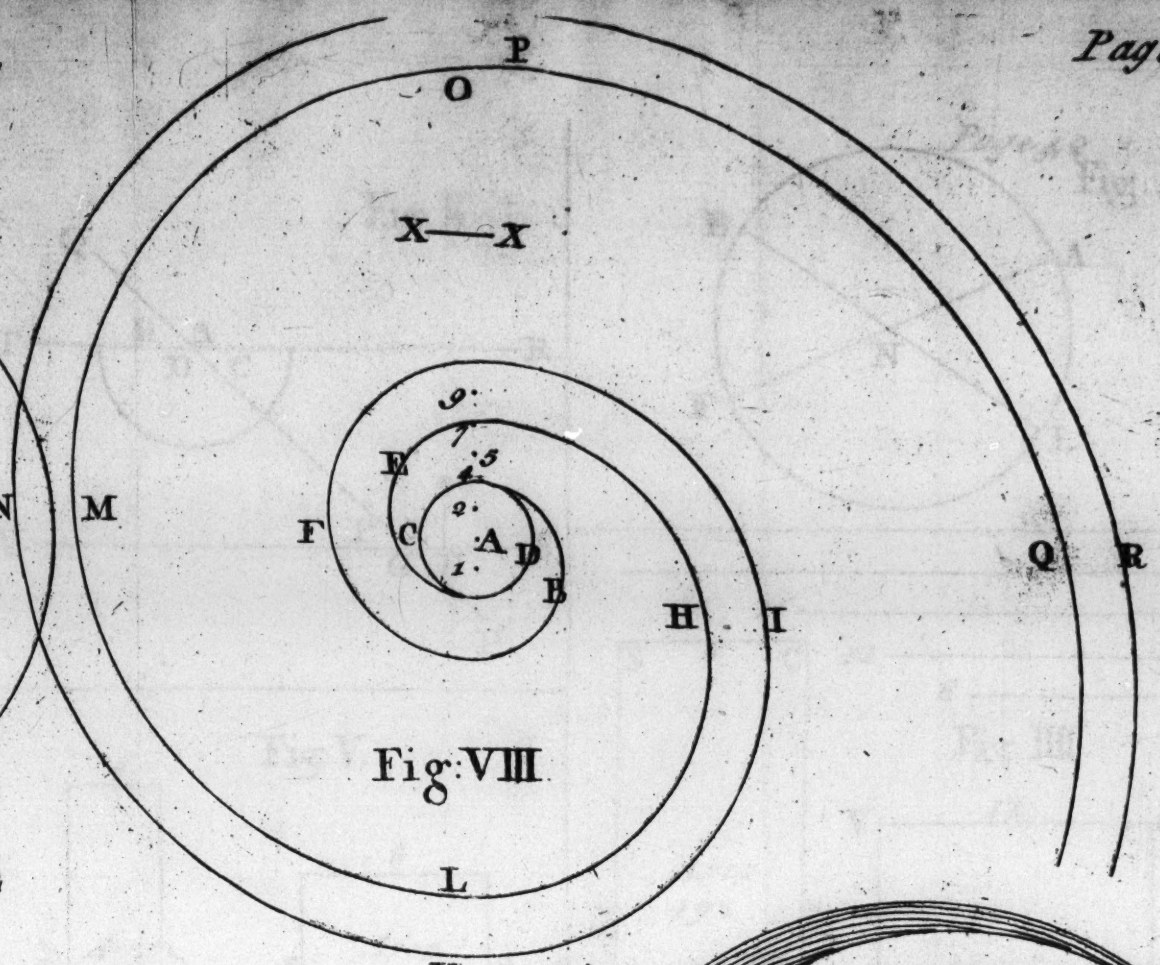

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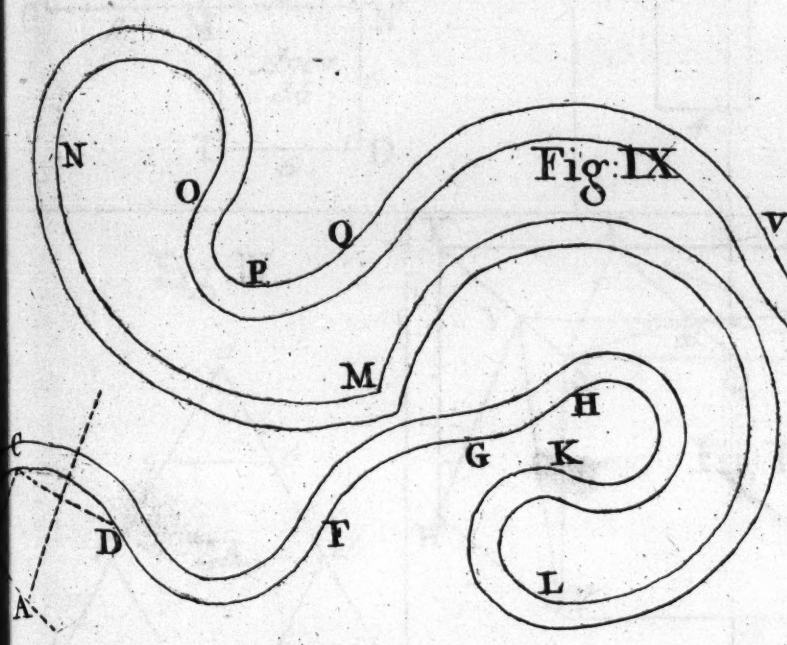

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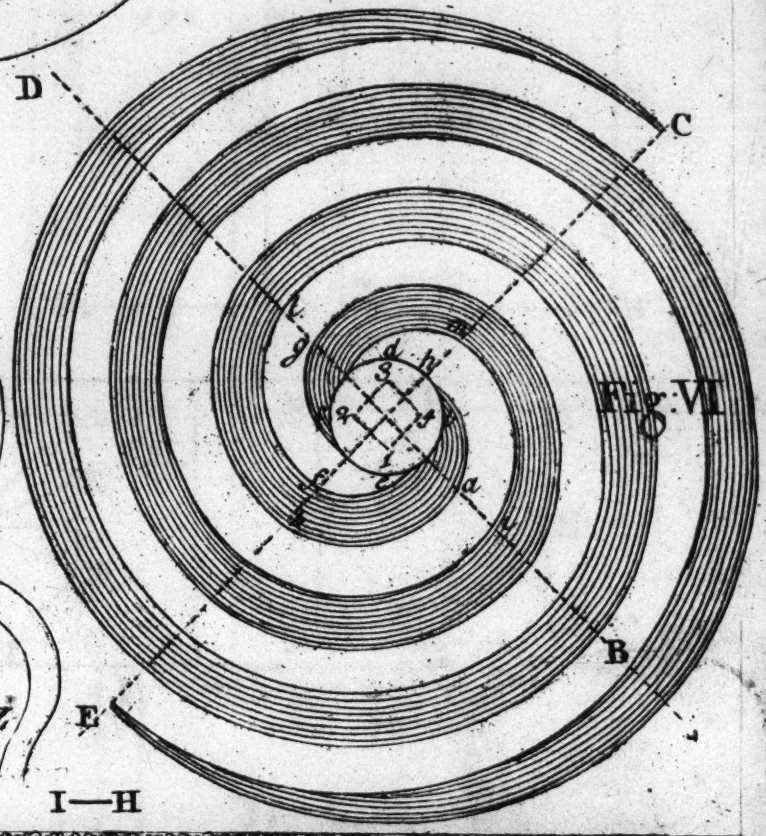

Fig: VI

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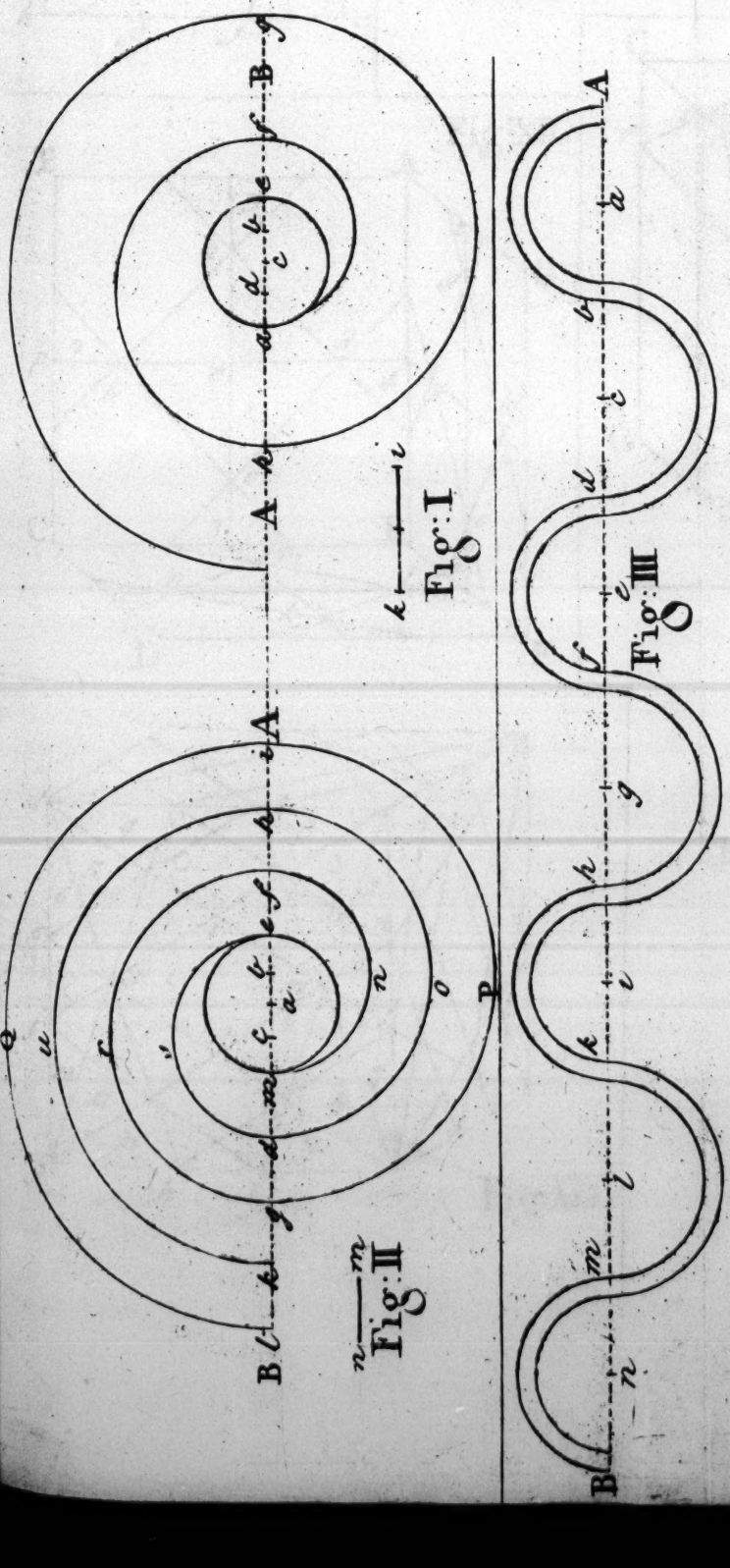

Fig: II

Fig: III

Fig: V

Fig: V

Plate IIII

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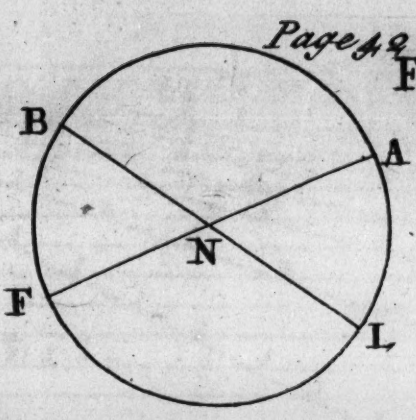
Fig: I.



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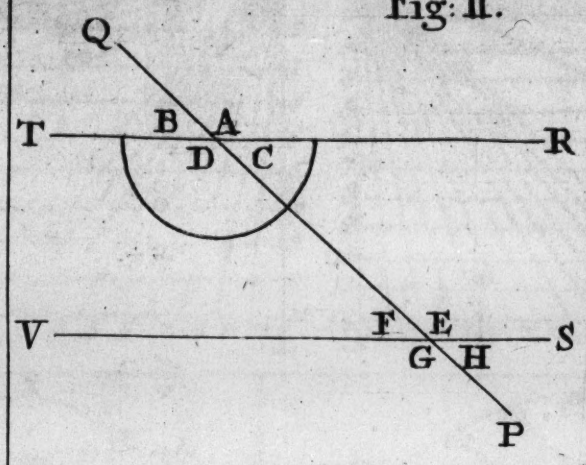

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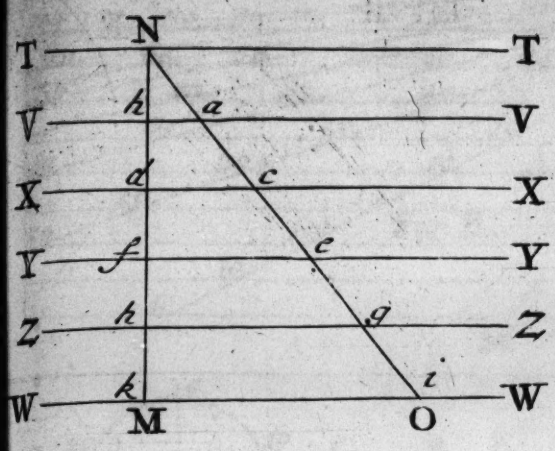


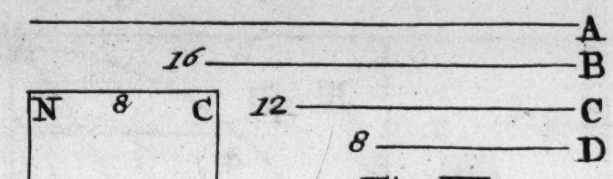
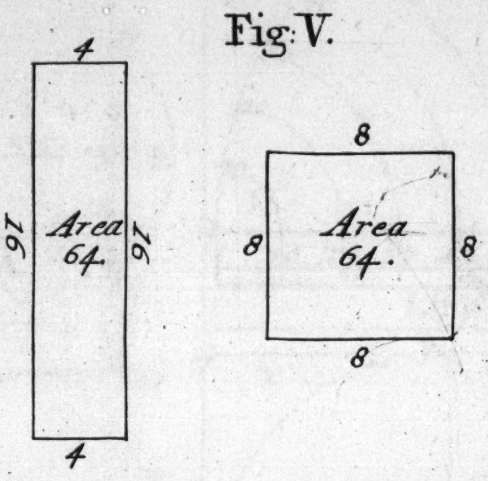


Fig: IIII.

Fig: V.



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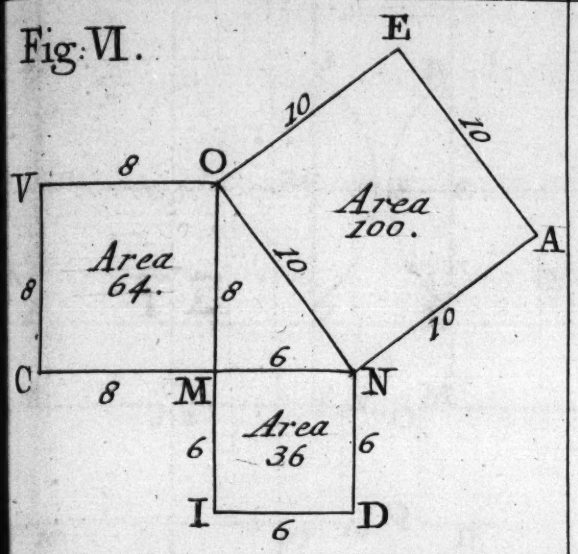

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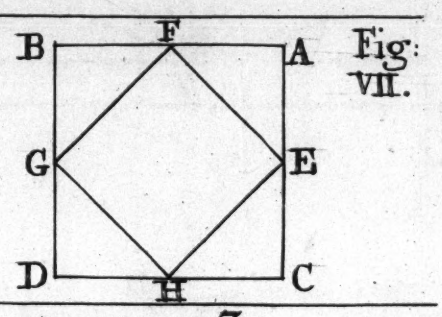

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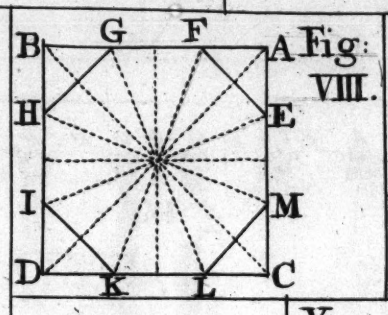

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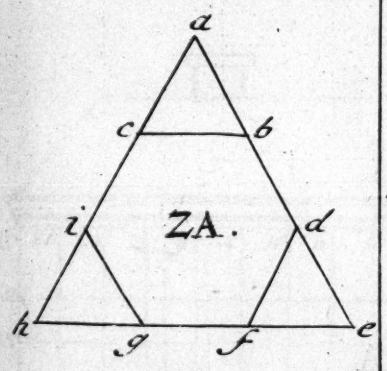


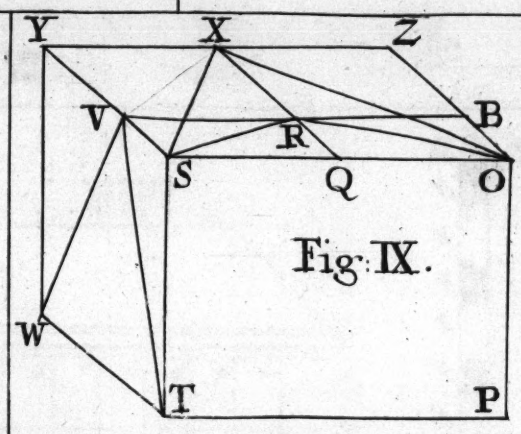
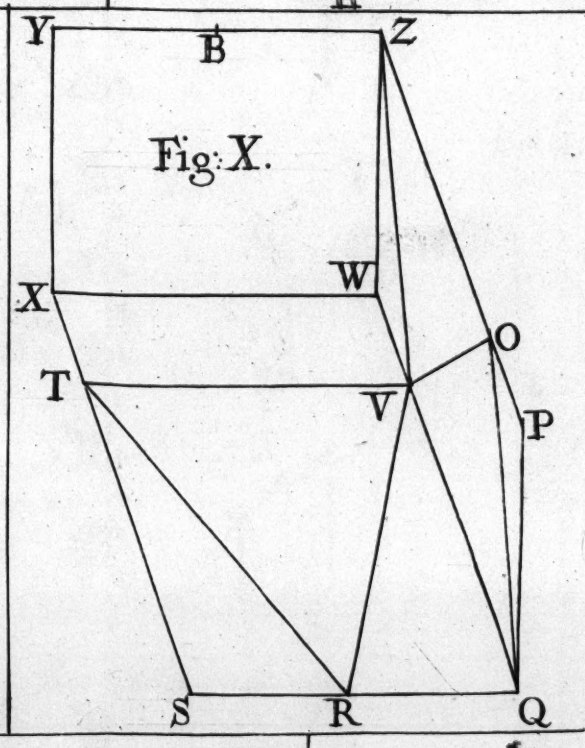


Fig: IX.

Fig: X.



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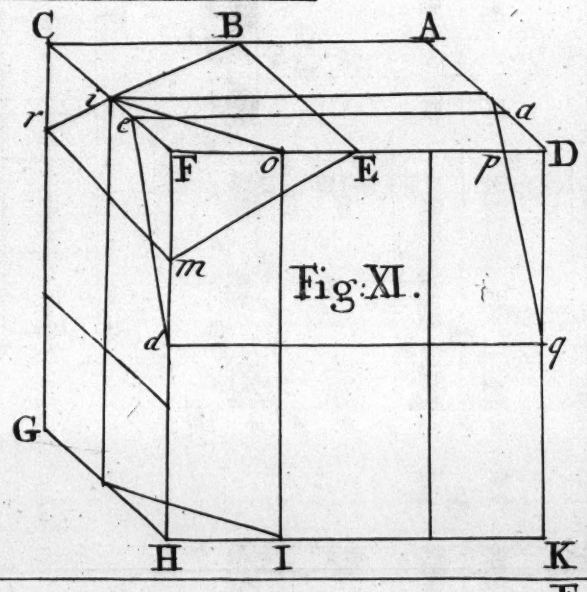

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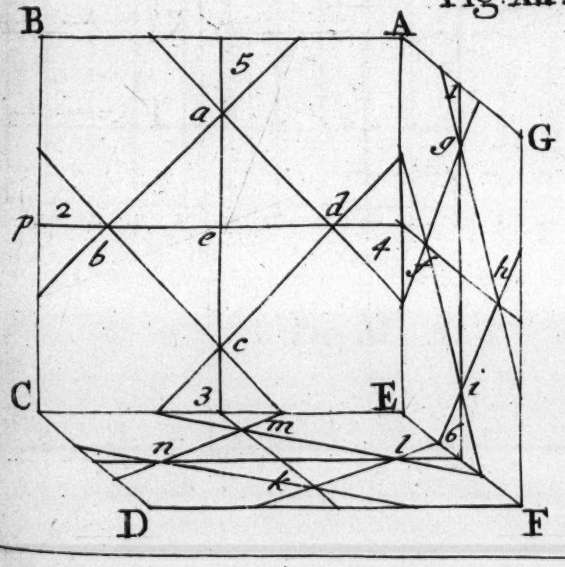

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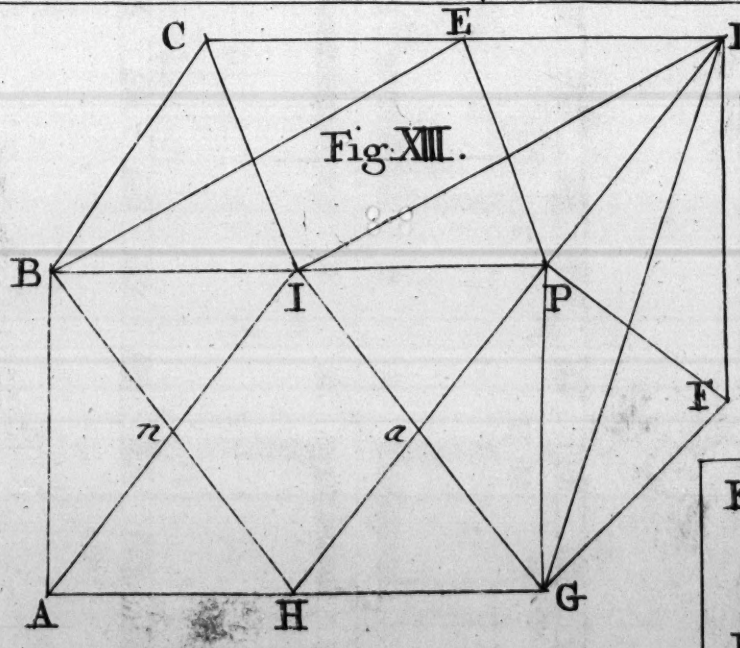

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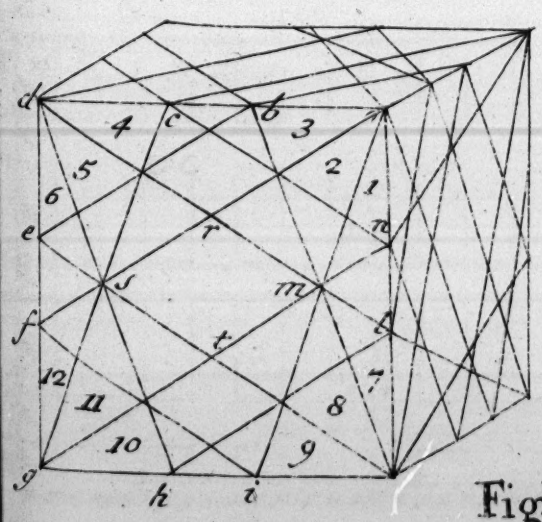

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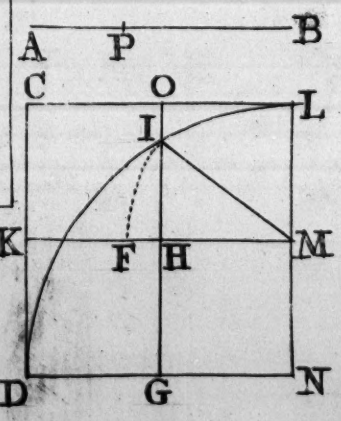

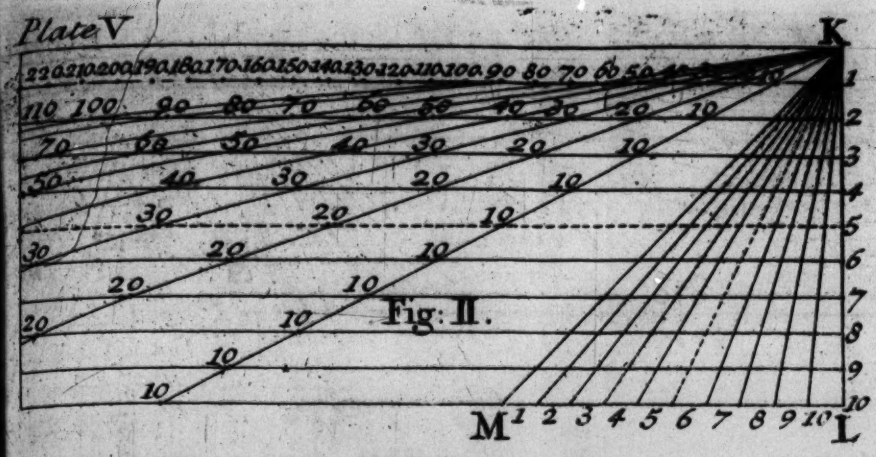

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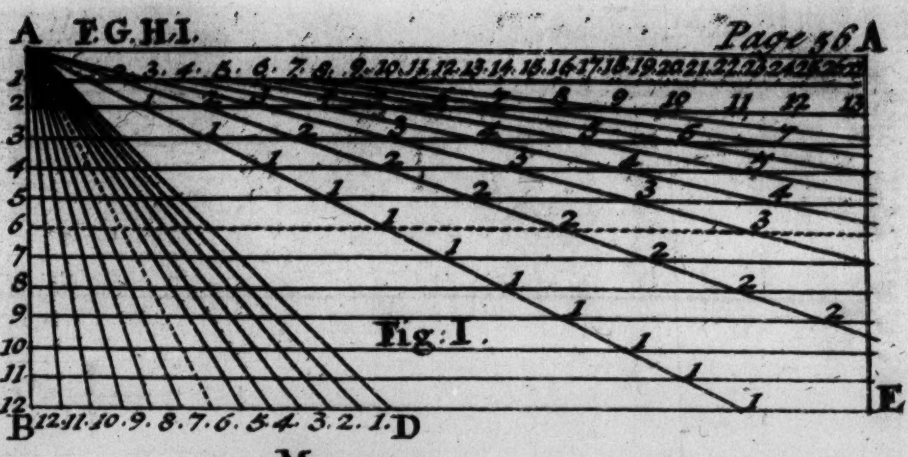

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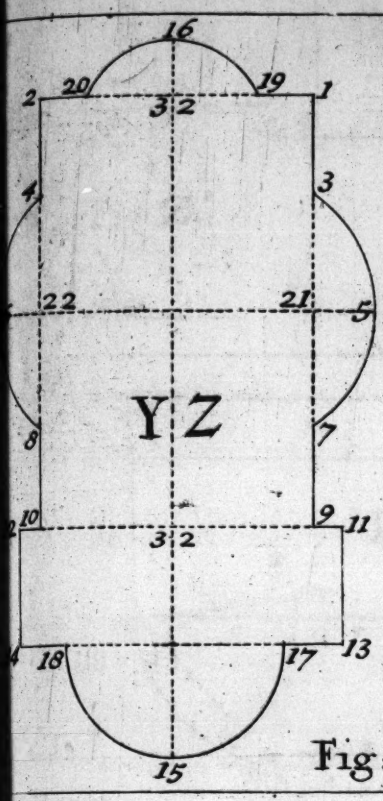

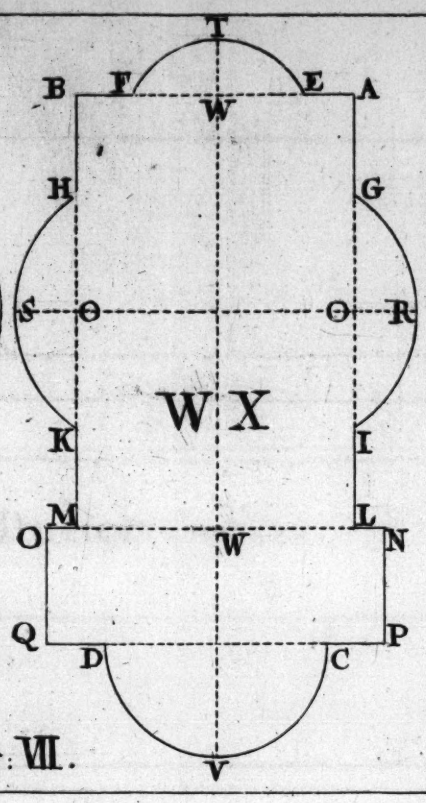

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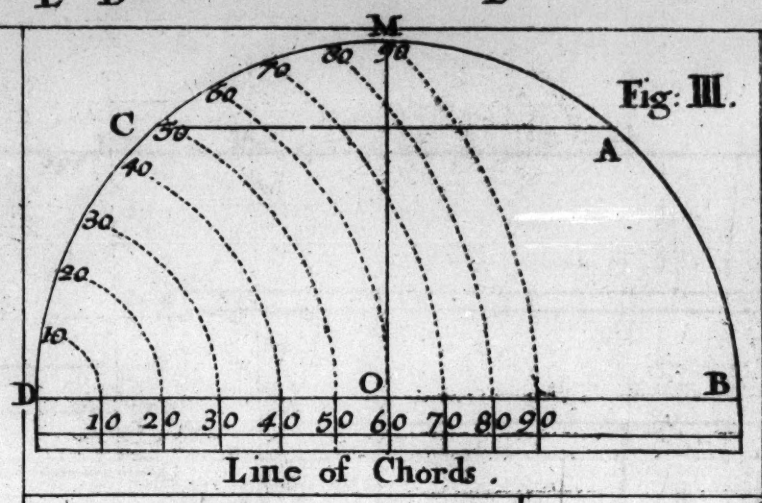

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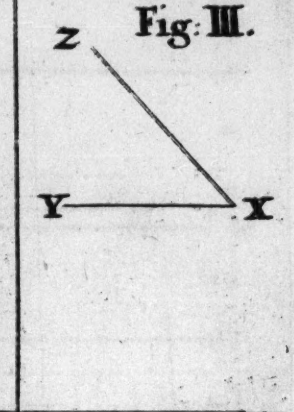

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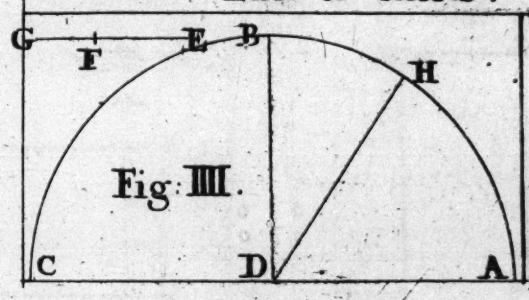

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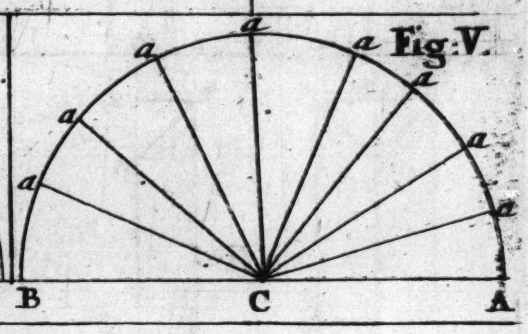

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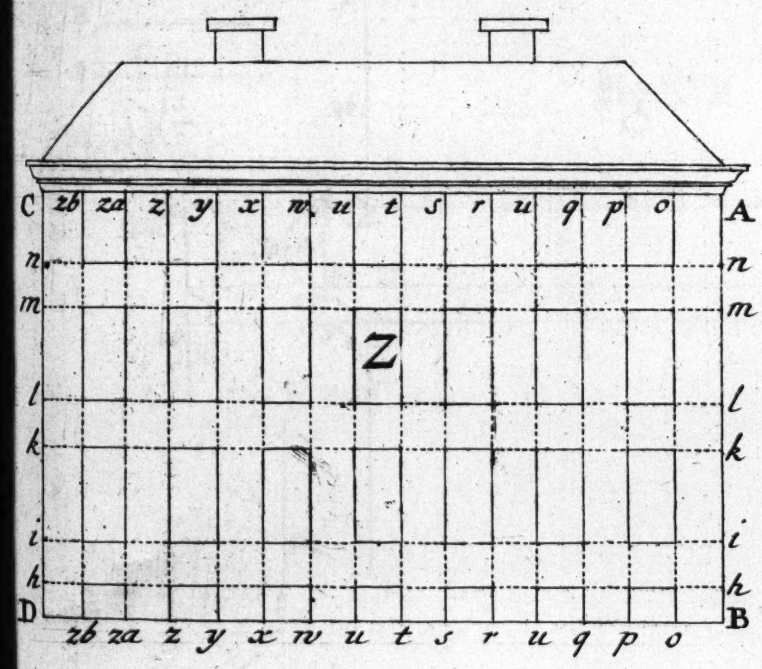

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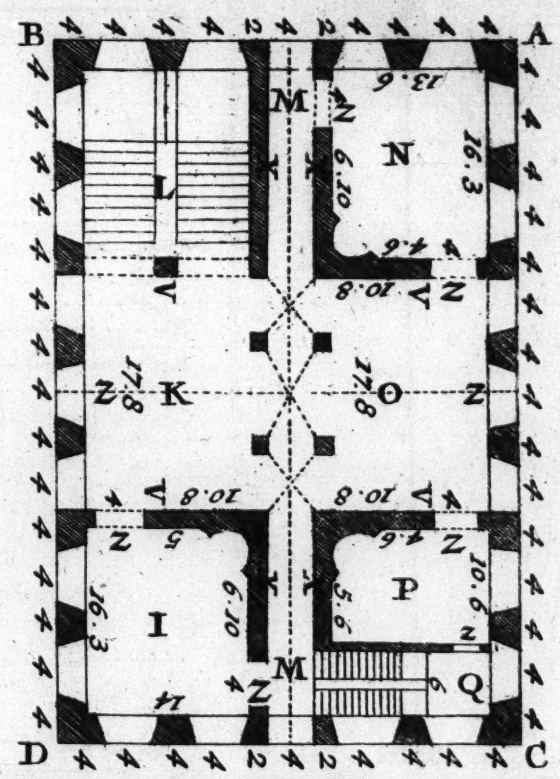

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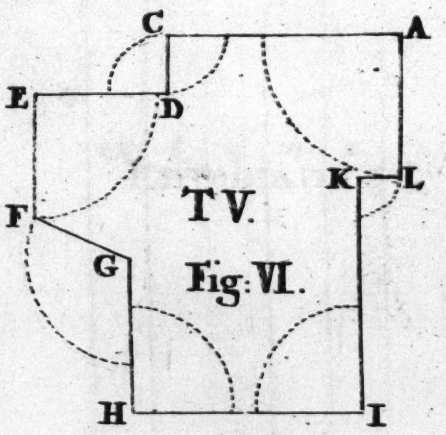

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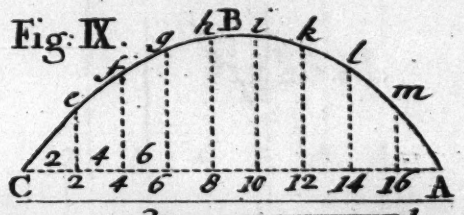

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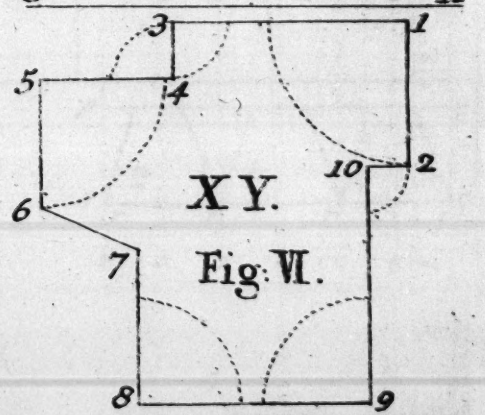

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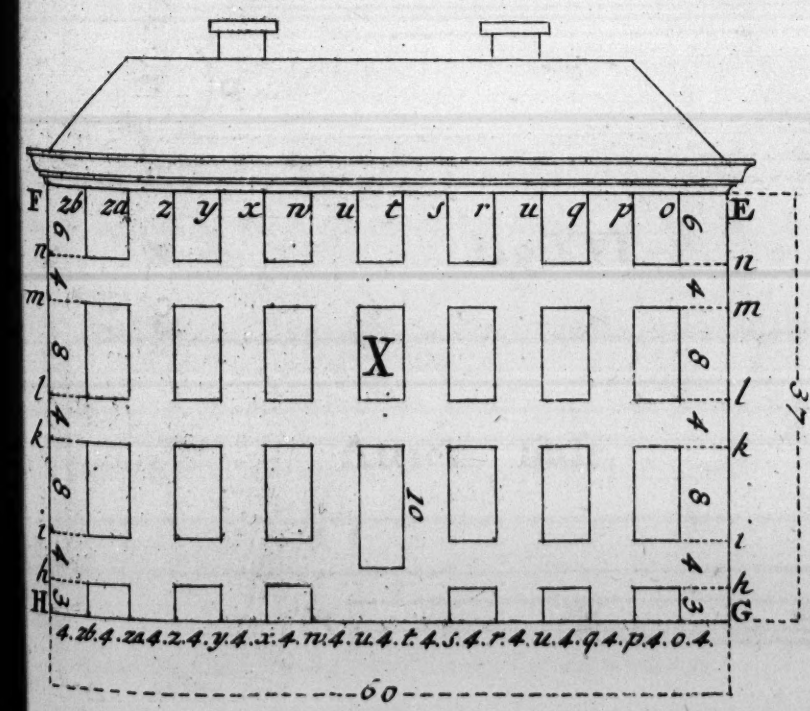

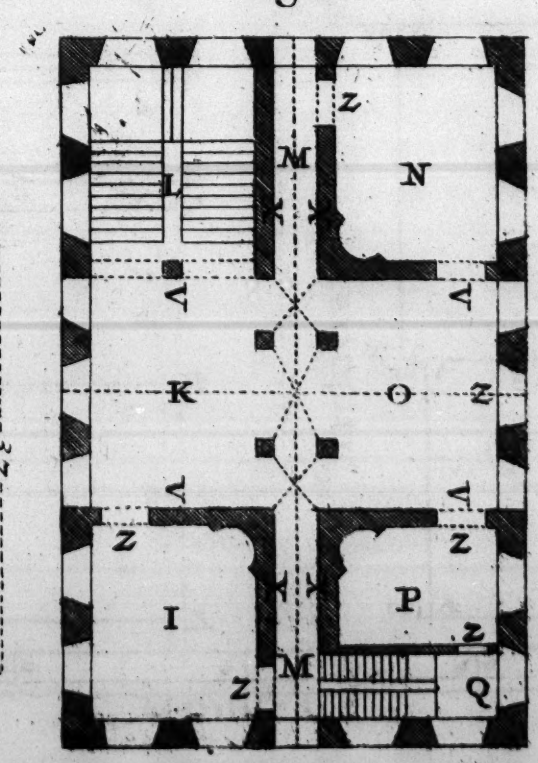

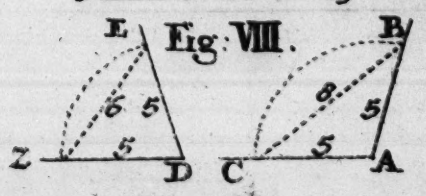

Fig: VIII.

Cornith

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Fig XVII

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Fig XVI

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Fig XVIII

Architrave

Minutes

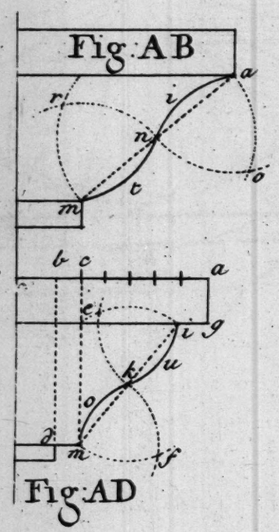
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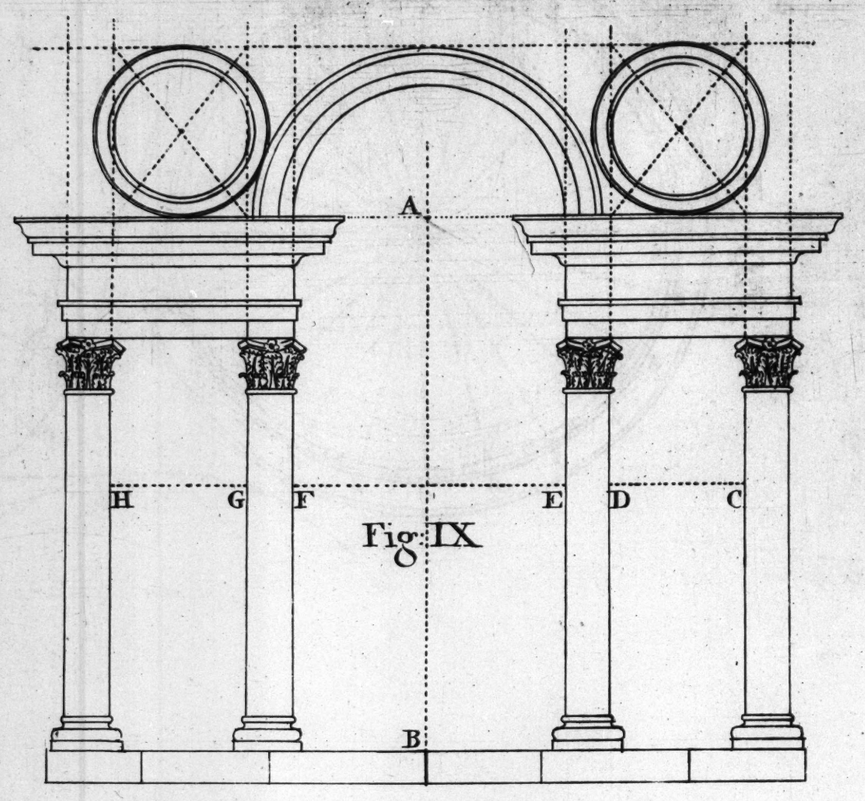
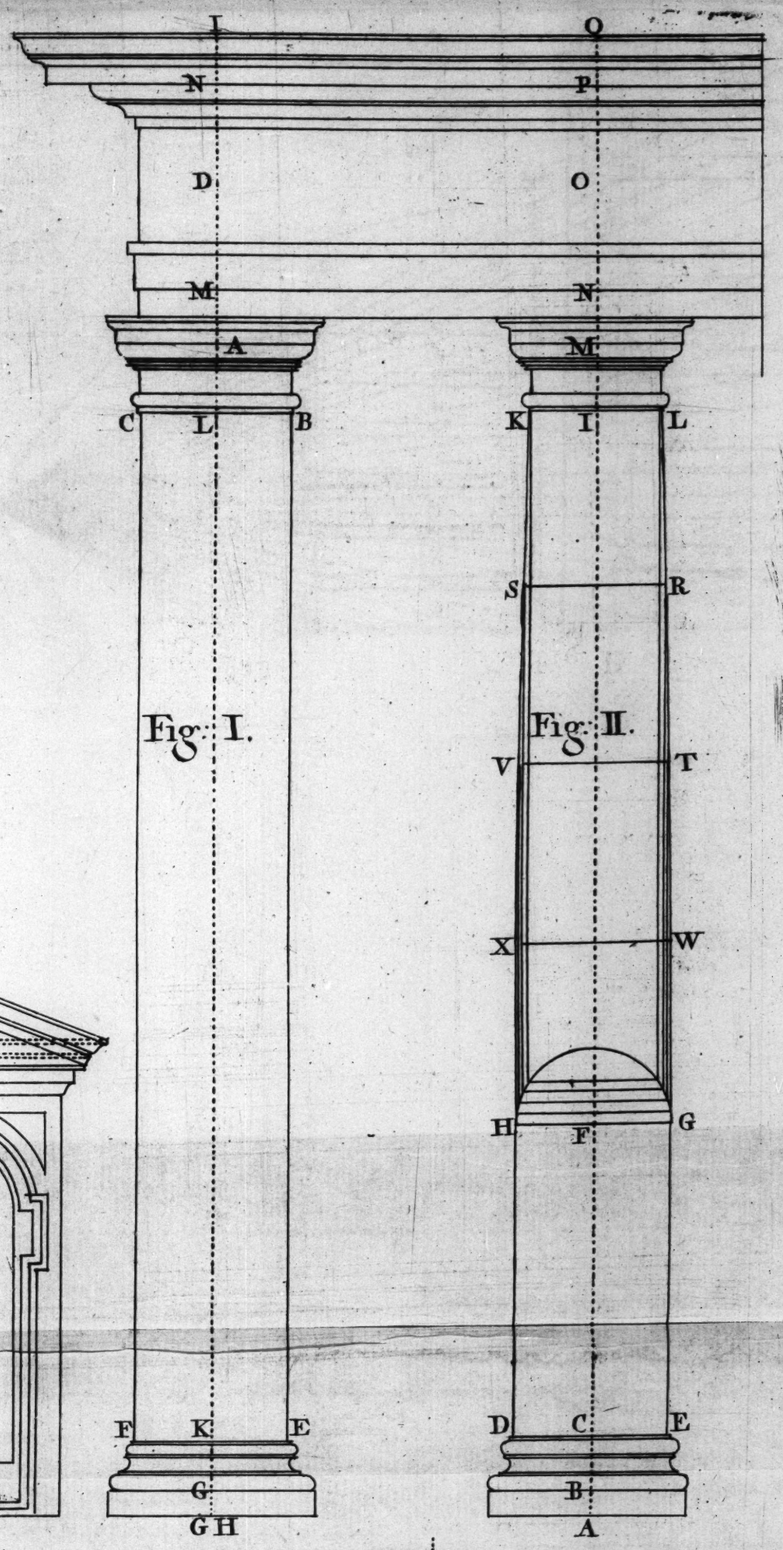
Fig: AD


A
H G F E D C
B
Fig: IX


I O
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K I L
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Fig: II.
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D C E
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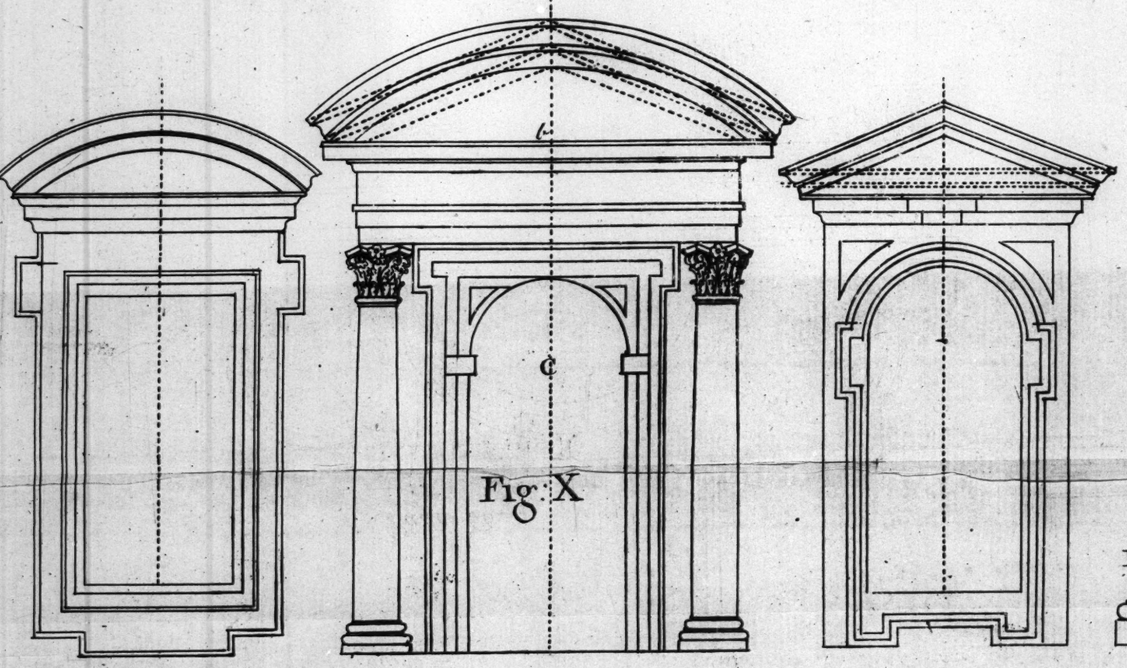
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Fig: X

Corinthian Shaft
Fig: VIII

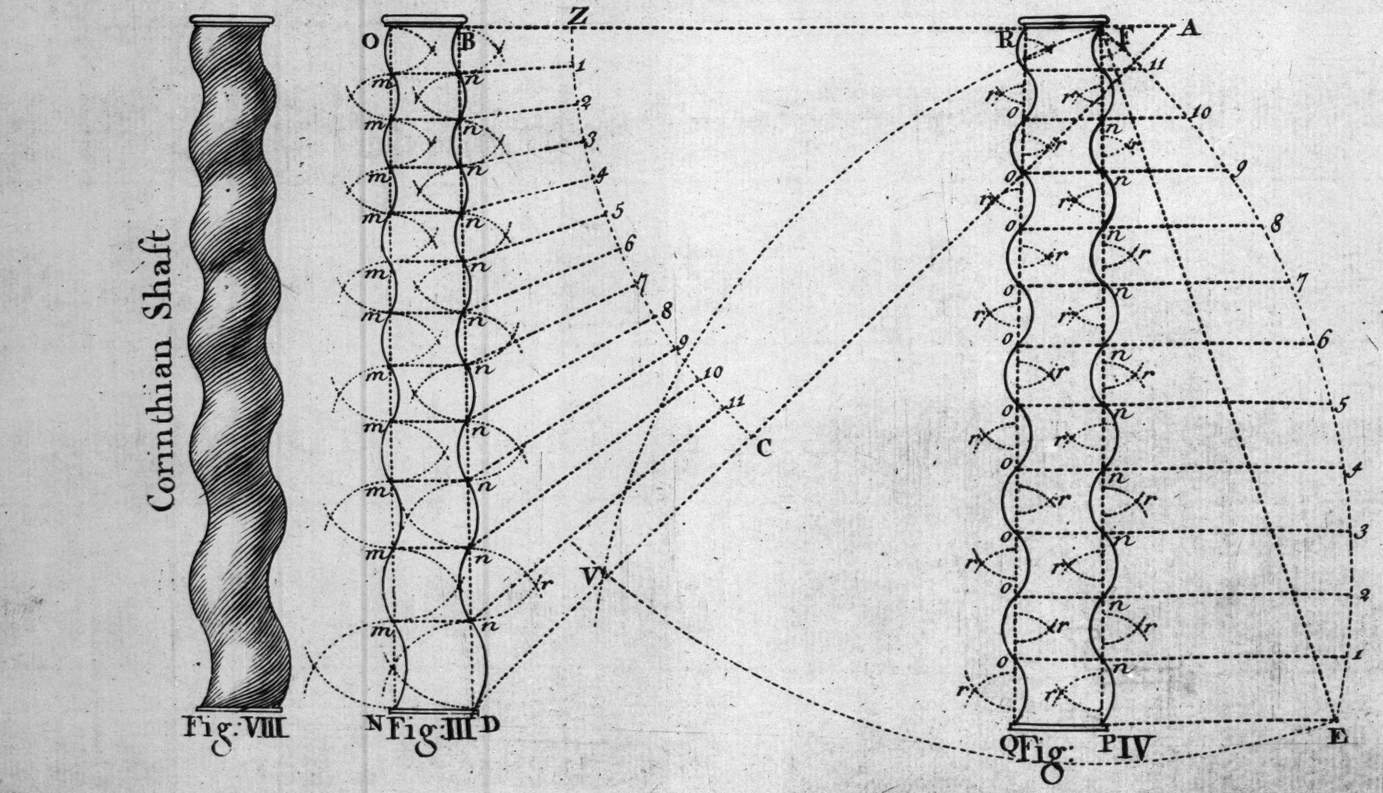
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Fig: IV

Ionick Shaft
Fig: VII

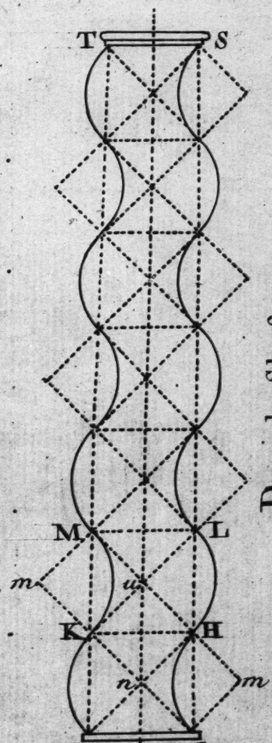
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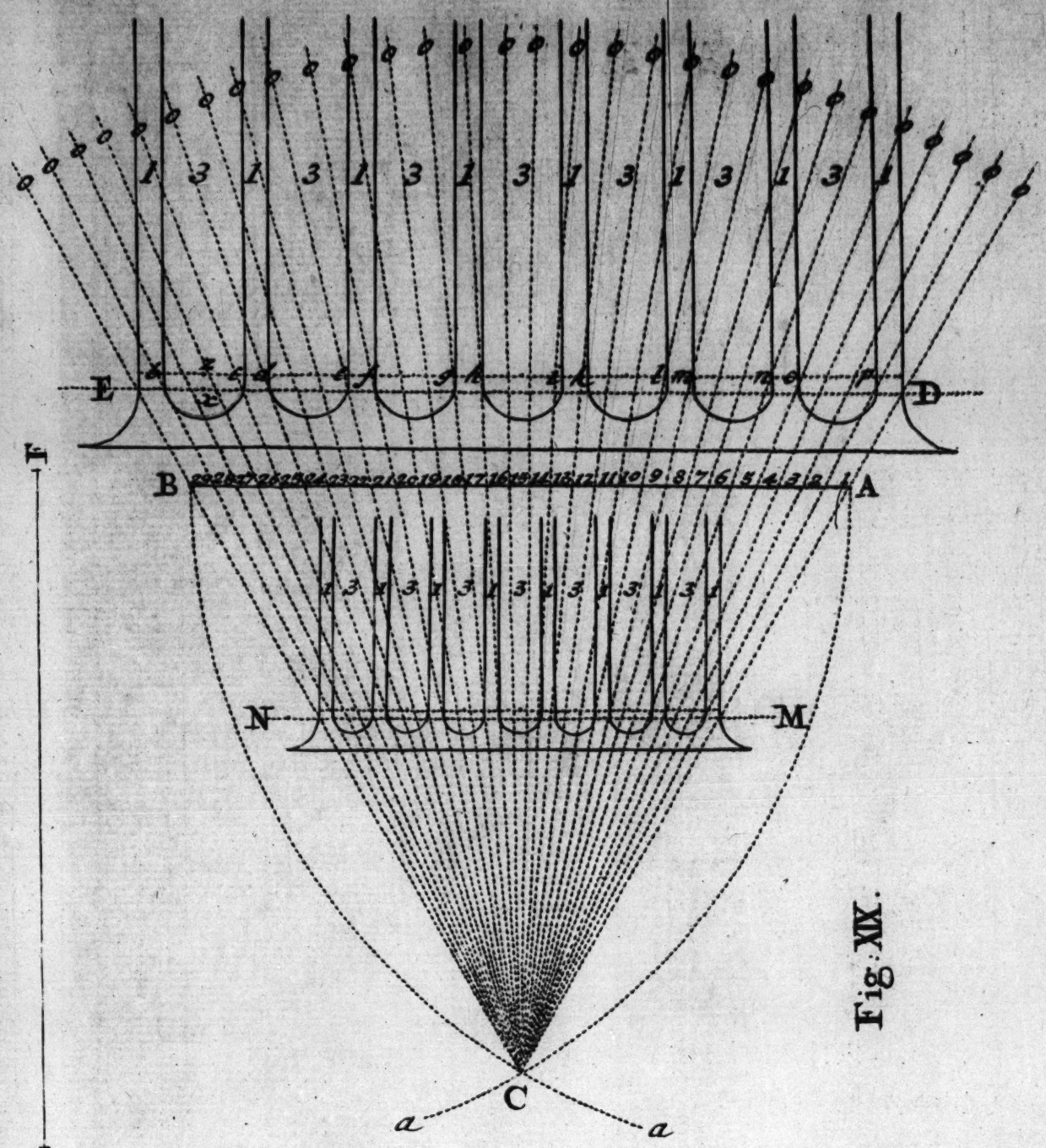
Fig: V

Dorick Shaft
Fig: VI



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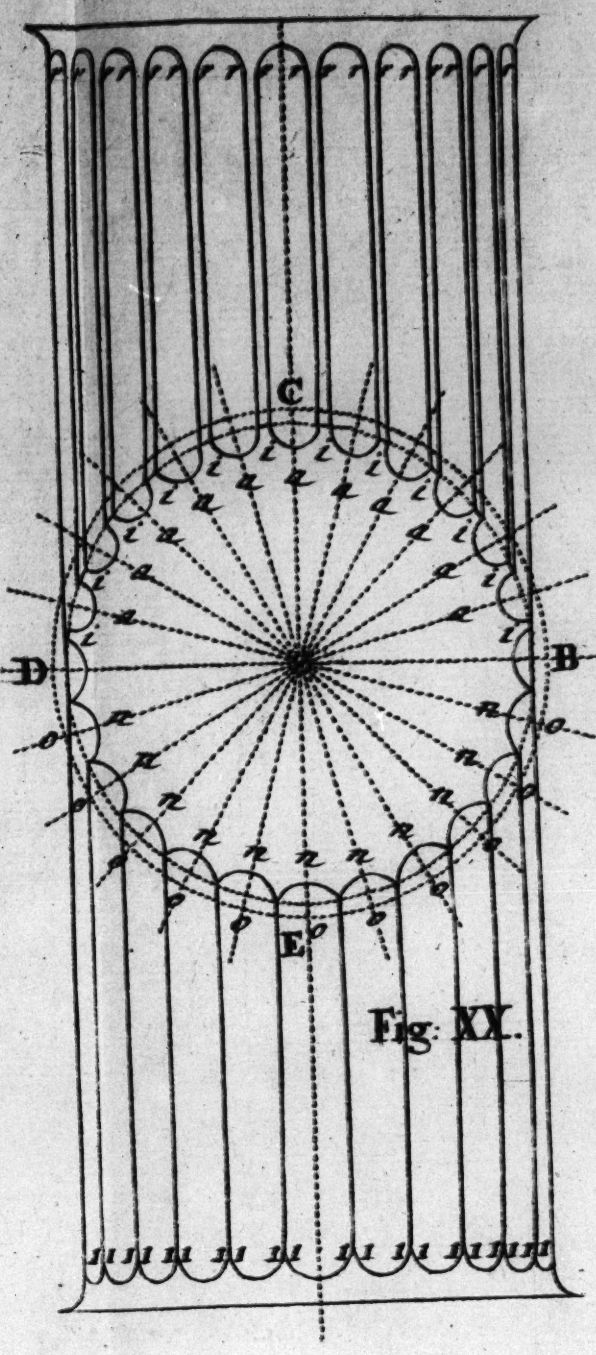
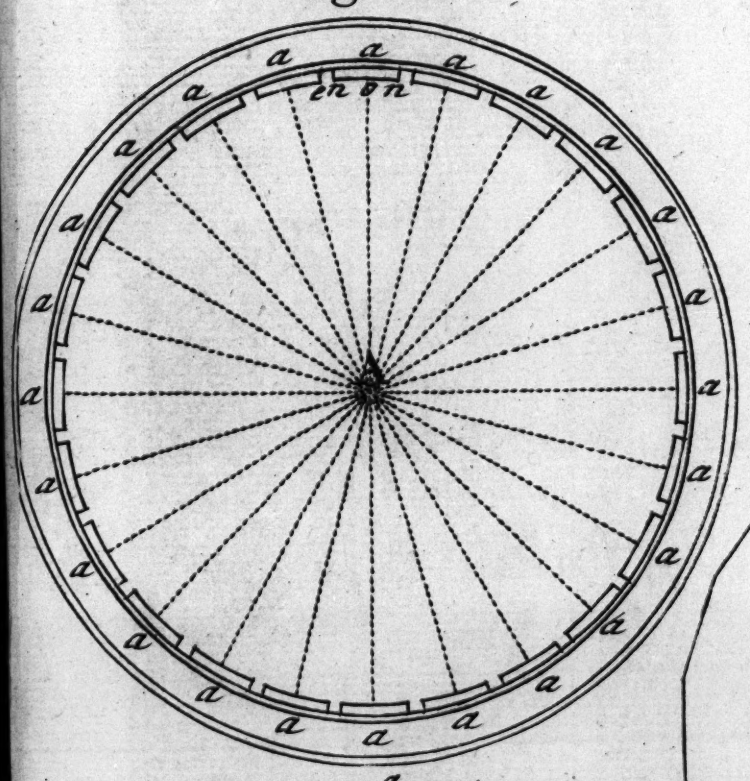


Fig: XX.

Fig: XXIV.



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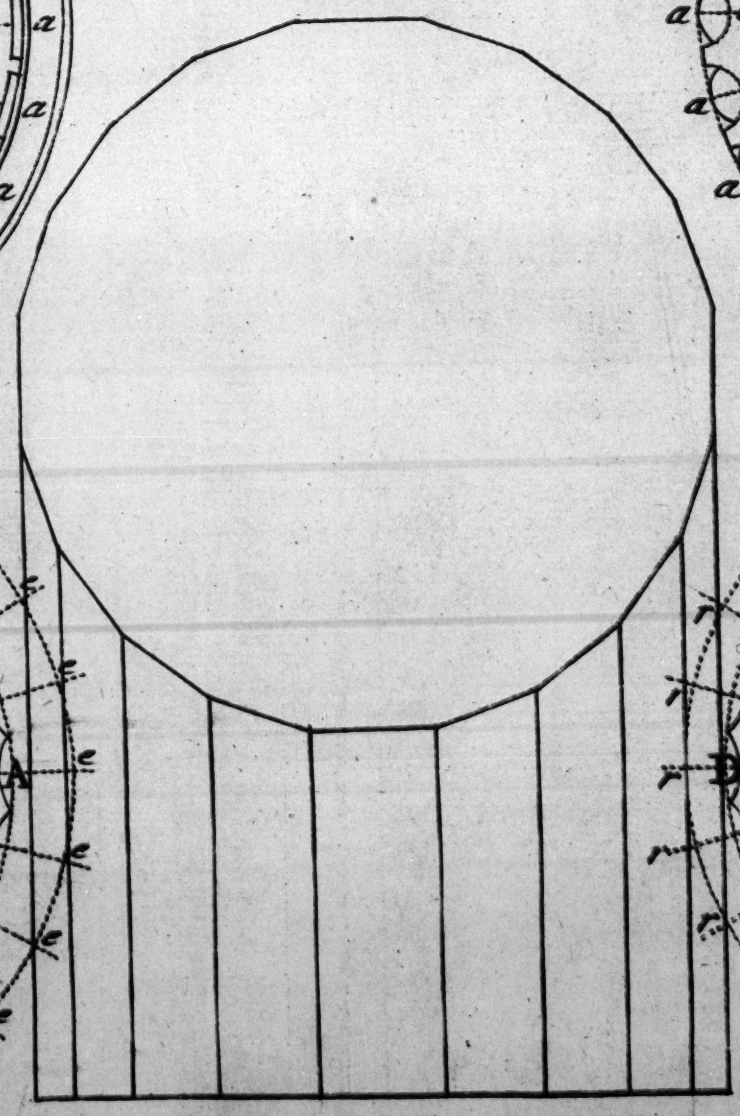

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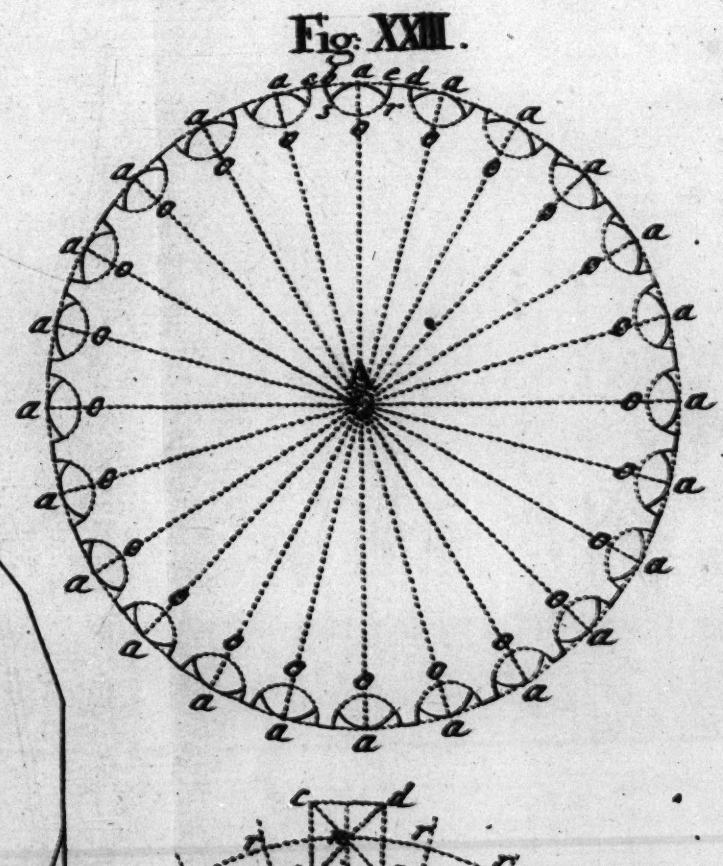

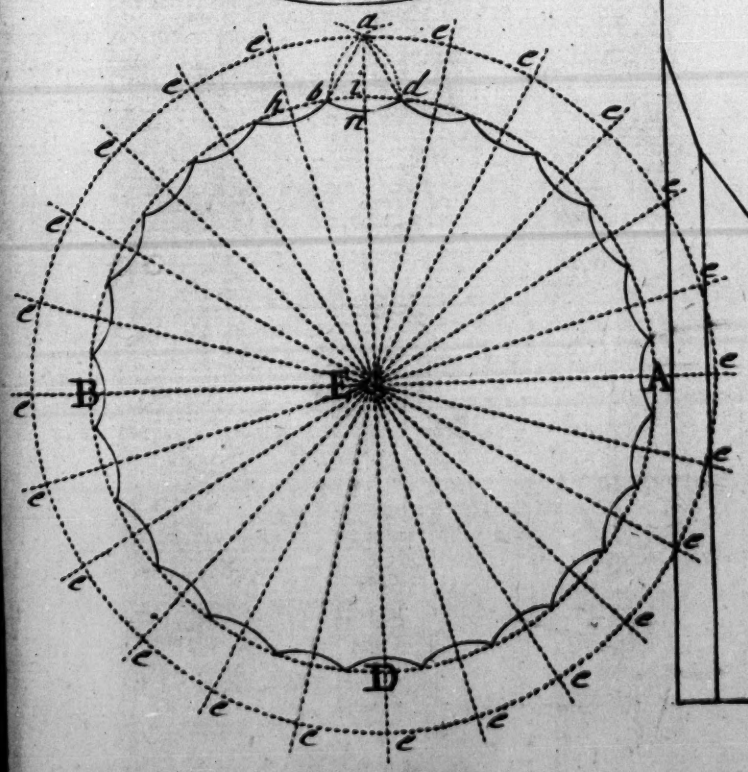

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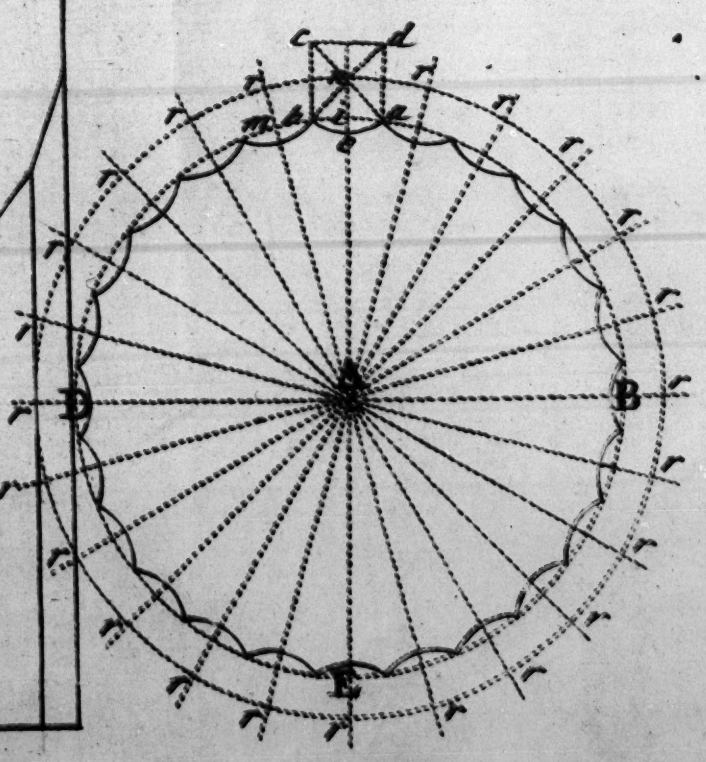

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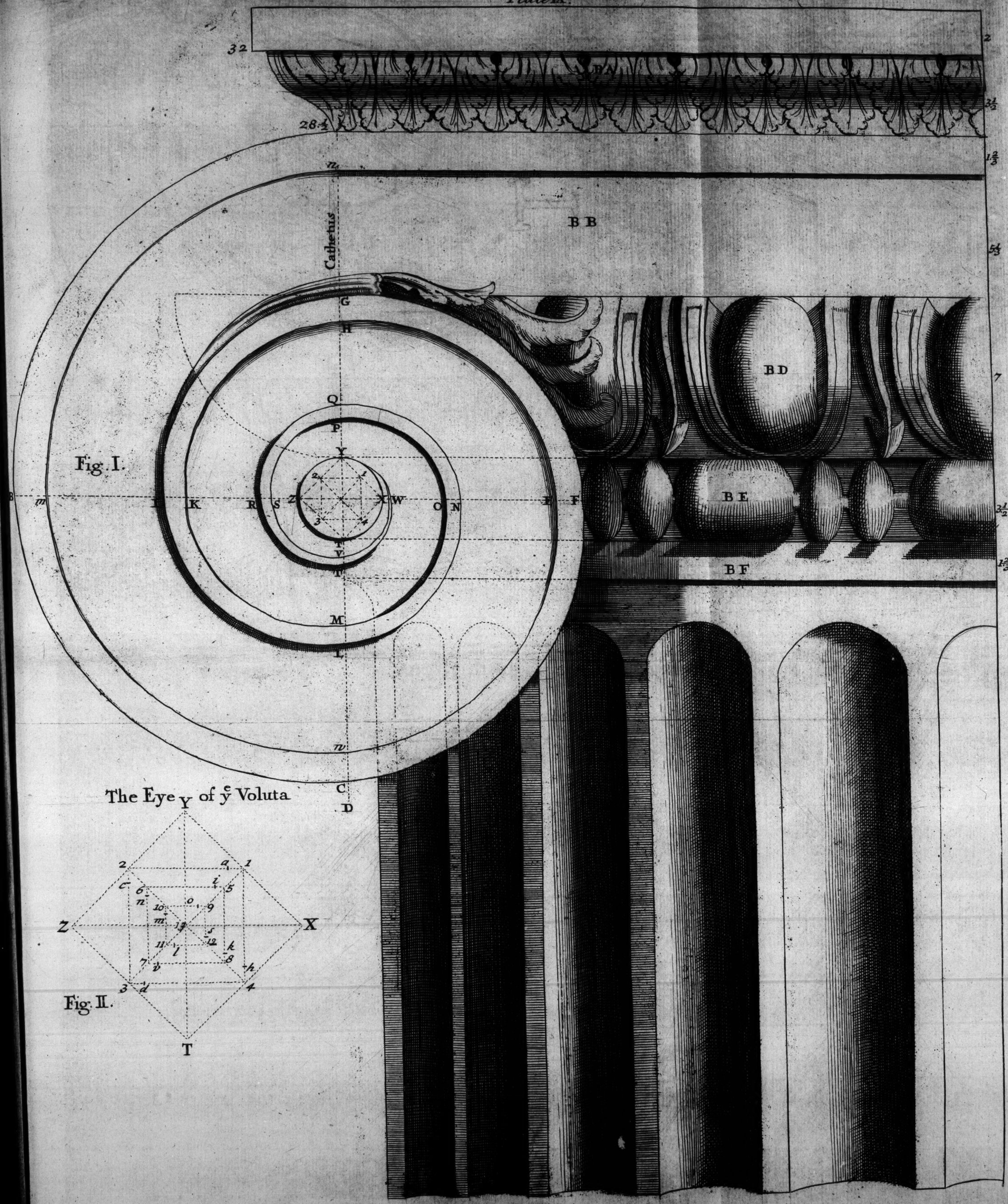
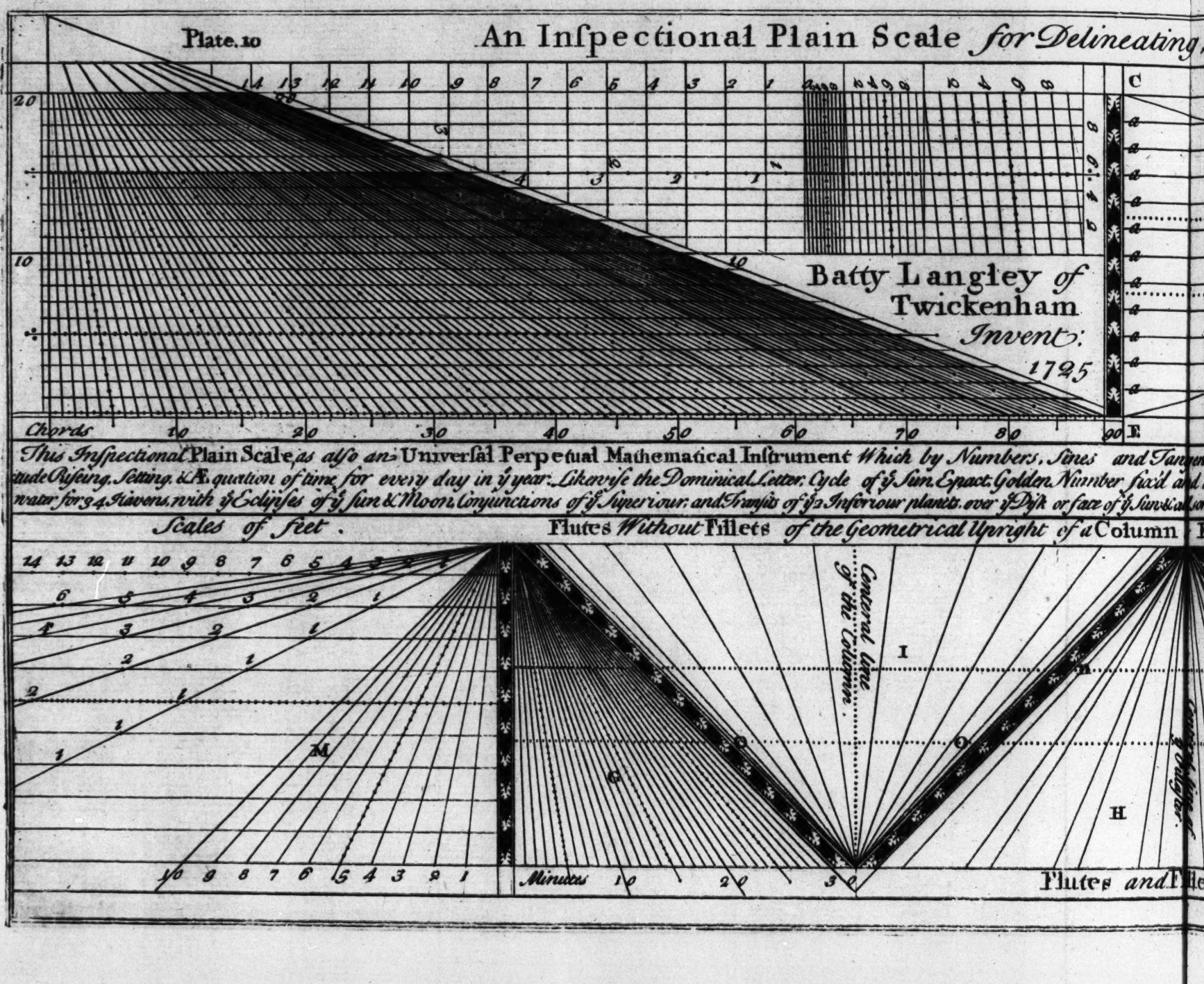


The Eye Y of ye Voluta

Fig. II.

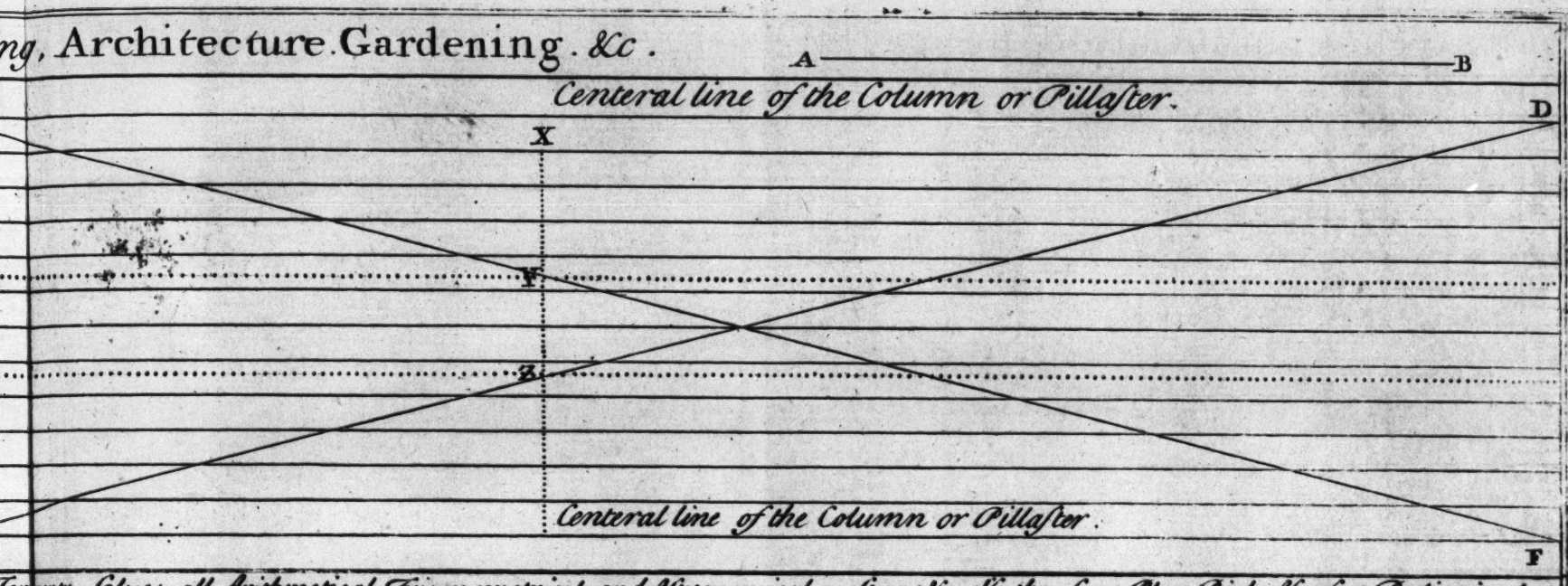
Plate. 10

An Inſpectional Plain Scale *for Delineating*

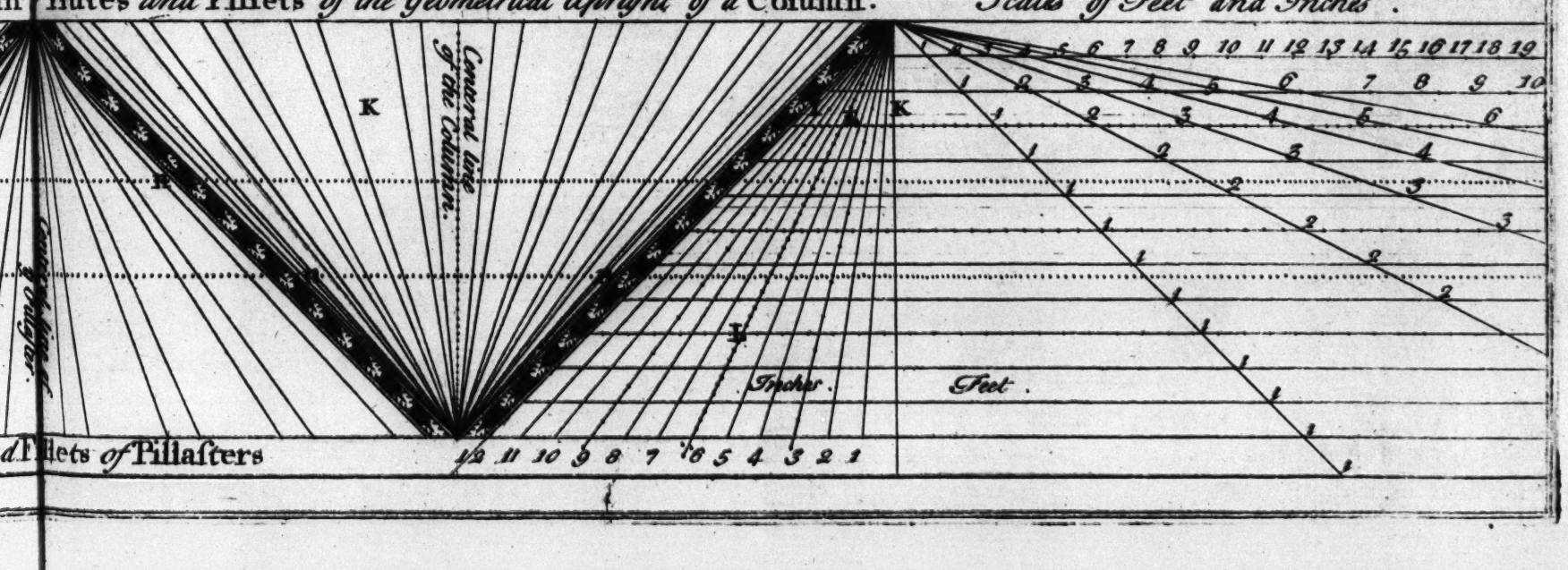


This Inſpectional Plain Scale, *as alſo an* Univerſal Perpetual Mathematical Inſtrument *Which by Numbers, Sines and Tan*
itude Riſeing, Setting, &c. quation of time for every day in ỹ year: Likewiſe the Dominical Letter: Cycle of ỹ Sun. Epact: Golden Number ſuc'd and
nrater for 34 Yeares, nrith ỹ Eclipſes of ỹ Sun & Moon, Conjunctions of ỹ Superiour: and Tranſits of ỹ 2 Inferiour planets. over ỹ Diſk or face of ỹ Sun: &c.

ng, Architecture. Gardening. &c.



Tangents. Solves all Arithmetical, Trigonometrical and Astronomical questions &c. also the Suns Place, Right Ascension Declination Ampli
d and moveable feasts. Terms and their Returns. New and full moon. her rising, Setting and place in ♈ Zodiack Southing and time of high
ical sors of Mathematical Instruments Made By Benj: Scott at the Mariner & Globe over against Exeter Exchange in the Strand LONDON.



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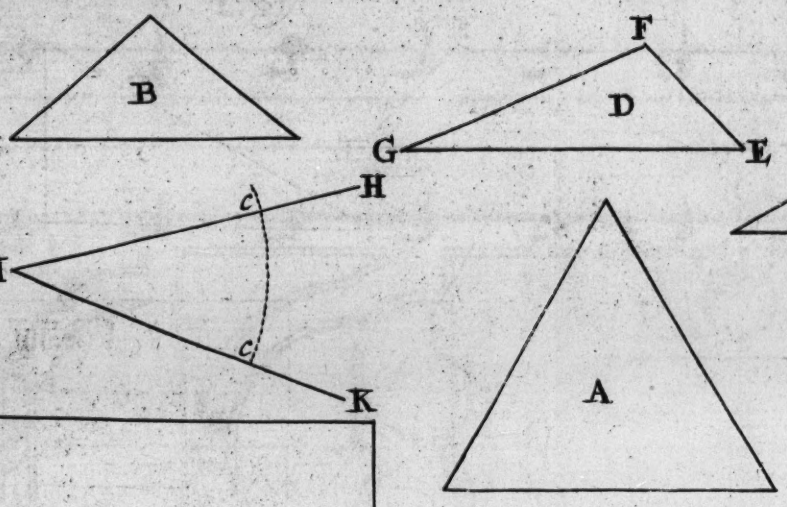

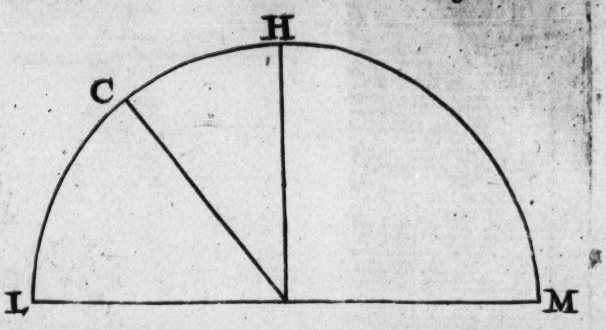

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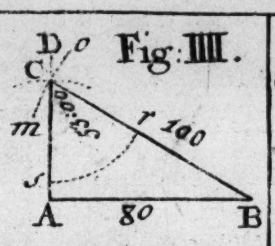

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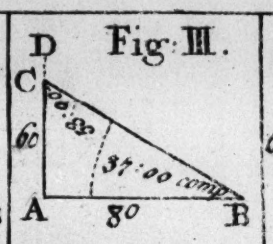

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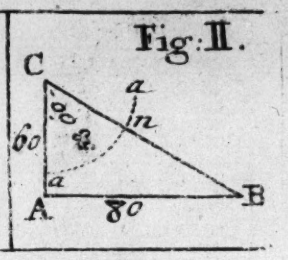


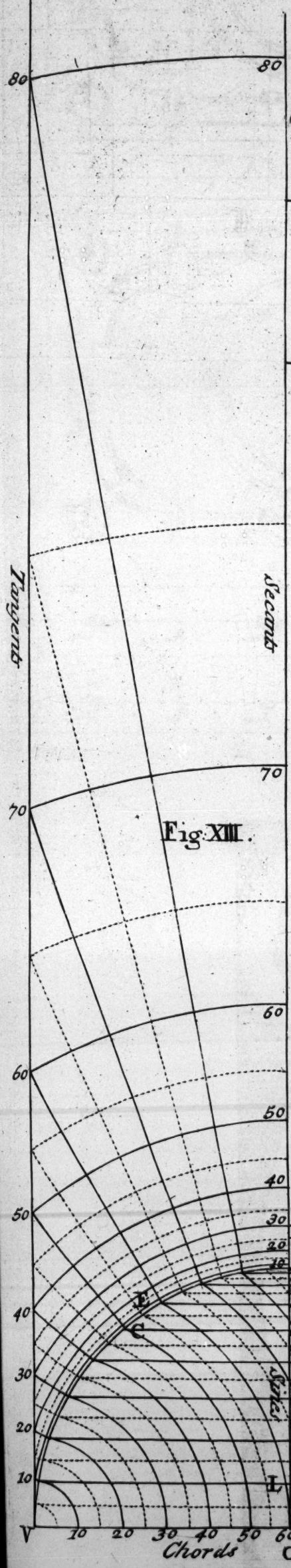
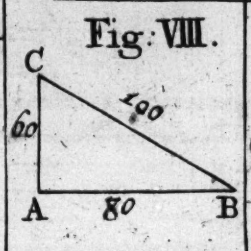


Fig: XIII.

Fig: VIII.



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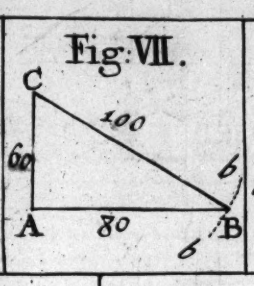

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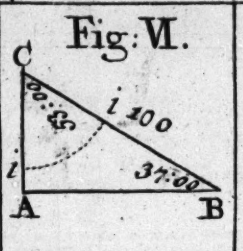

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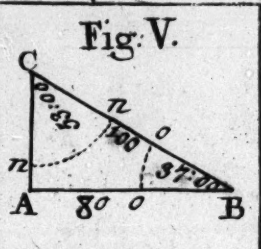
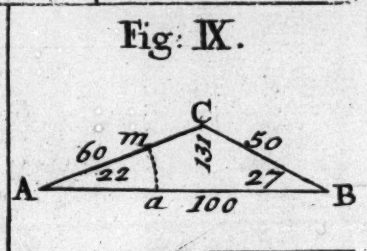


Fig: IX.



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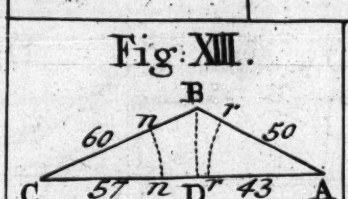

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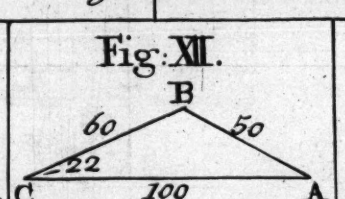

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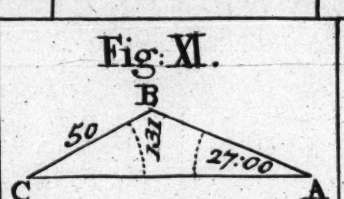

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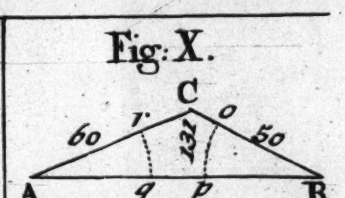


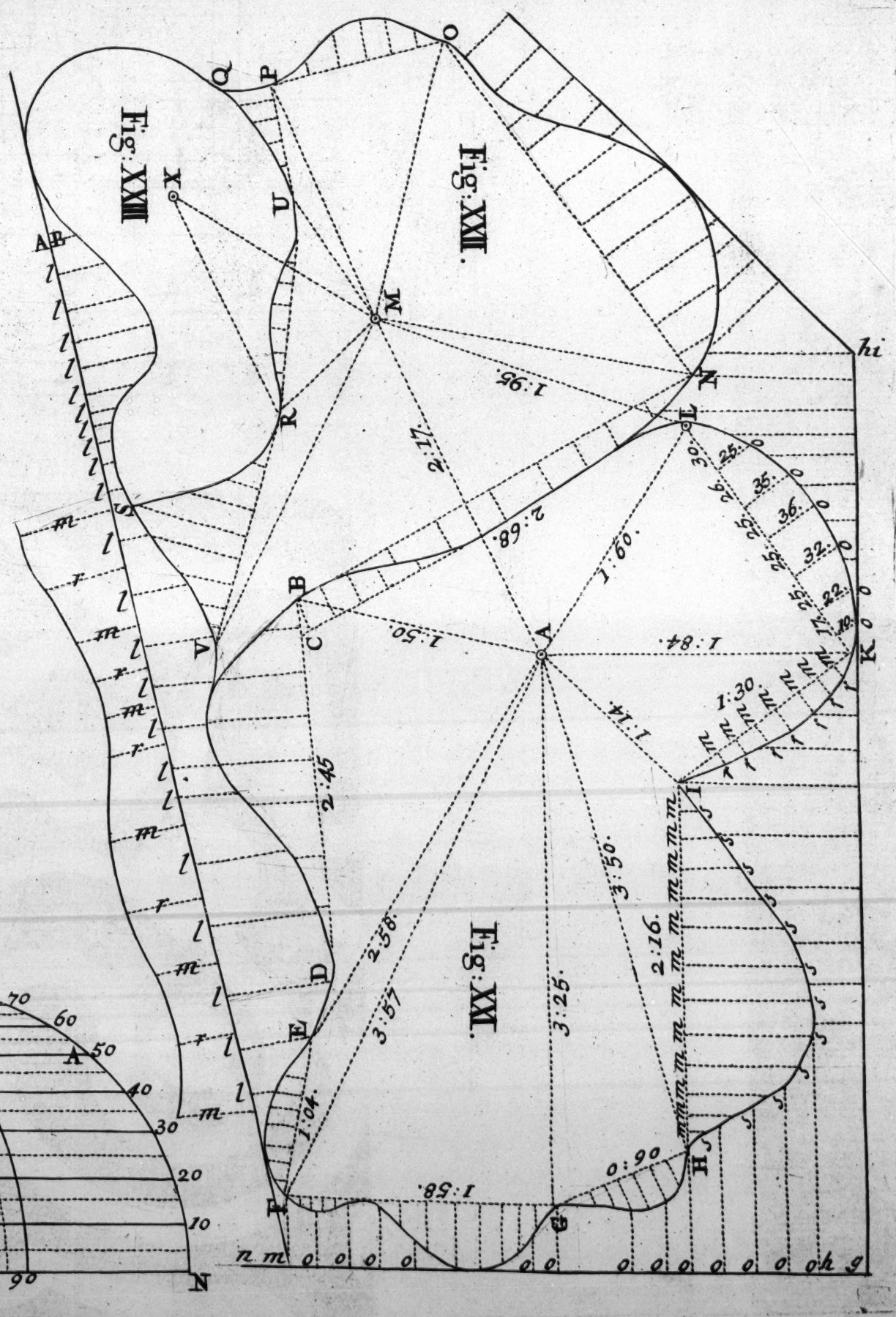


Plate XII

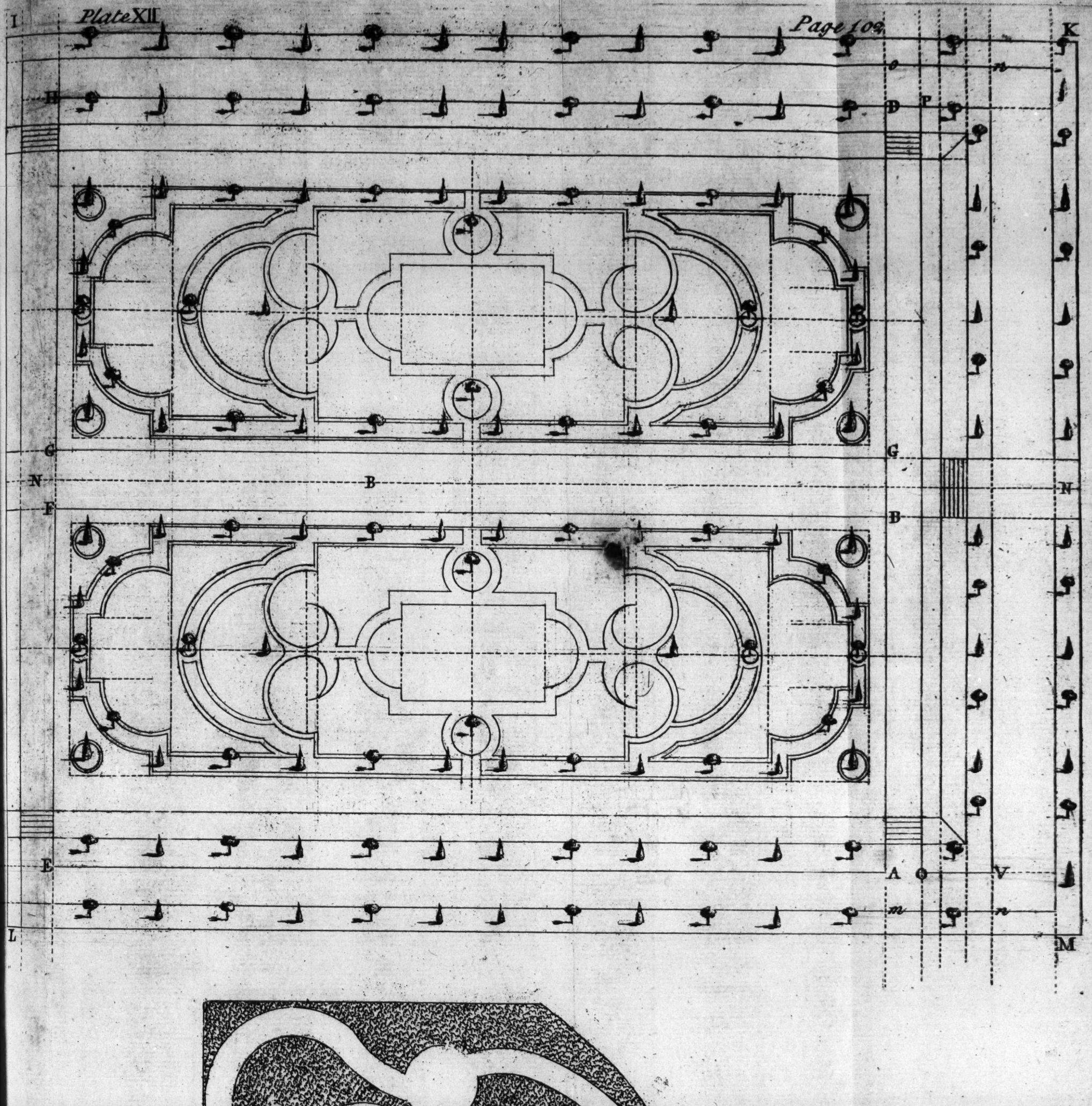
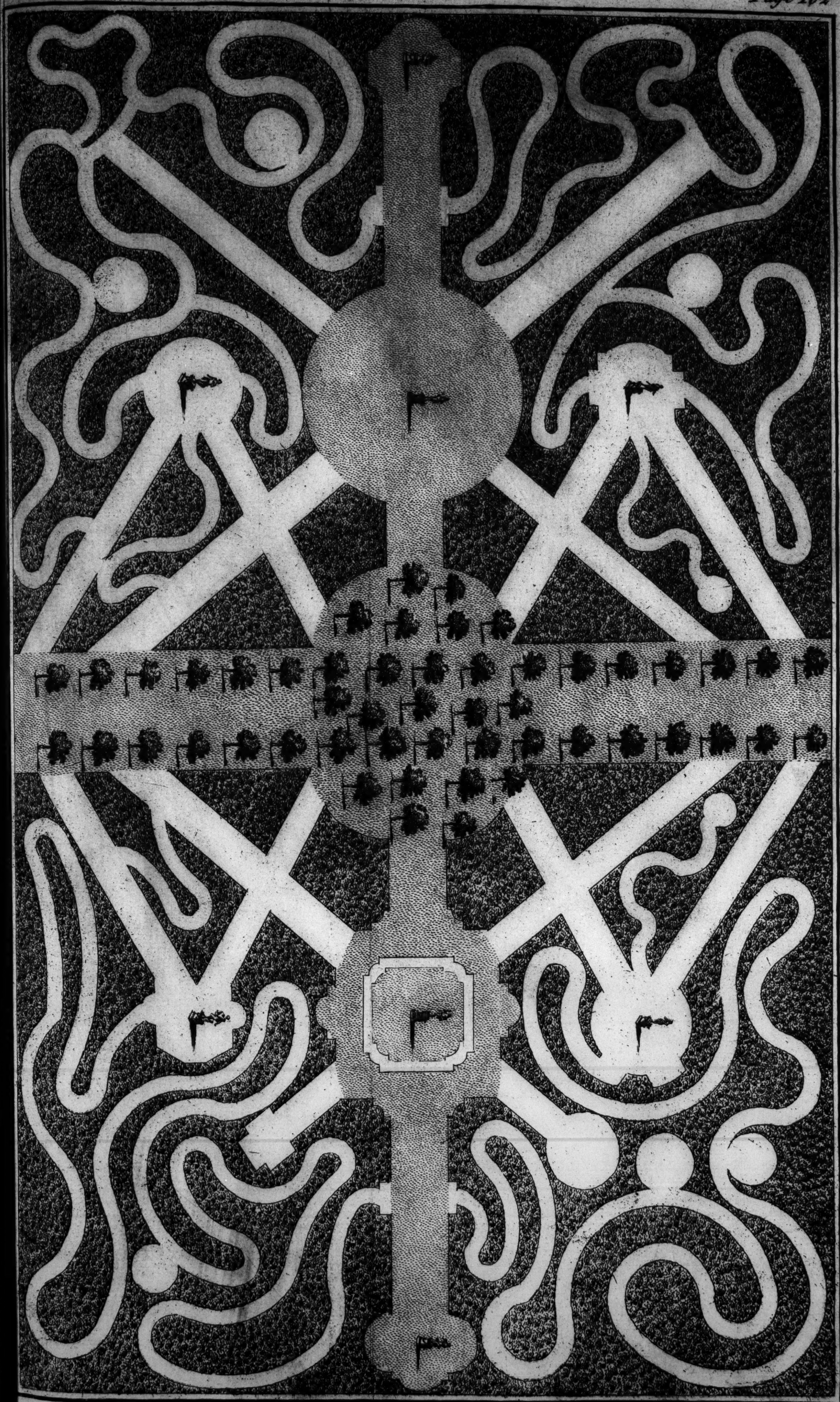


Fig XXVI



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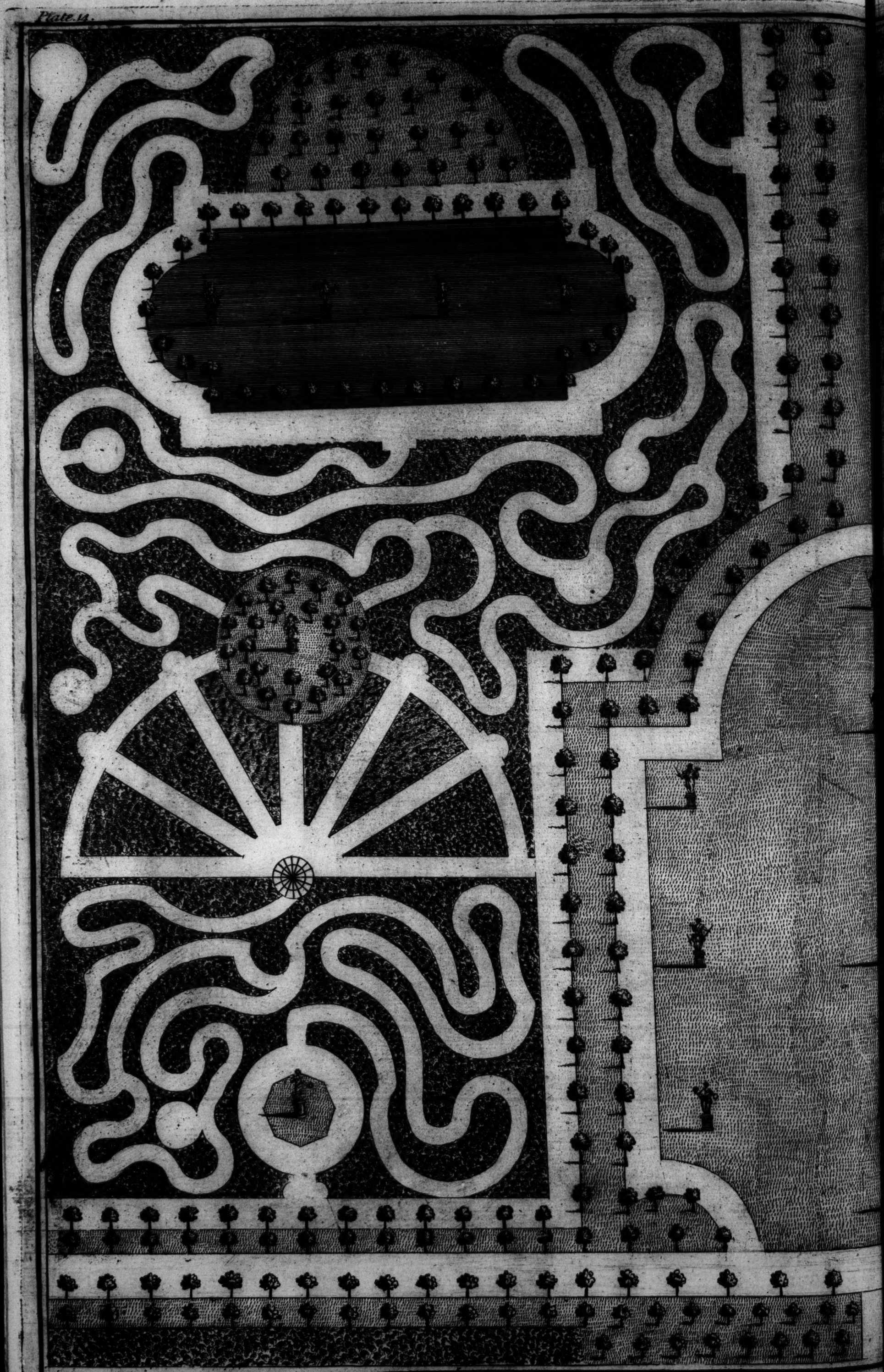

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CREDON FARM

The Lands of y^e Honourable AB.
Scituated in the Parish of T.
In the County of S.
Survey'd and Mapp'd By B.L.

Table of Contents

		Acre	Rood	Pole
A	Broom Feild	4	2	9
B	Calfs Plat	2	0	27
C	Stump Close	4	3	29
D	Fern Feild	7	2	11
E	Cow Close	3	0	7
F	Well Close	3	3	9
G	Marsh mead	4	1	15
H	Little eight	3	1	7
I	Barn Close	6	1	20
K	Nuns Close	6	3	21
LM	Nuns Wood	3	2	9
M	Crums Feild	5	3	37
N	Home Close	5	3	31
OB	House Yards &c.	2	1	20
P	Mutton Close	1	3	10
Q	Stacken Close	4	0	7
R	Sheep Pasture	4	1	9
S	Buns Close	3	1	21
T	Brook mead	4	2	11
V	Plum bush Feild	4	1	2
W	Marvel hole	3	1	7
X	Marvel hill	2	3	10
Y	Bulls Meadow	3	3	17
	Sum Totall			

Quantity of Timber in NUNS WOOD.

	L	F		L	F		L	F		L	F
1	1	7	10	0	20	19	1	7	28	2	10
2	0	40	11	0	49	20	1	20	29	1	7
3	2	7	12	1	20	21	1	17	30	0	29
4	2	10	13	1	33	22	0	10	31	1	17
5	2	1	14	2	9	23	1	41	32	2	11
6	1	31	15	2	2	24	2	3	33	2	5
7	1	9	16	1	31	25	2	15	34	3	18
8	2	11	17	0	47	26	3	5			
9	2	3	18	2	9	27	3	11	Totall	57	17

Plate XV

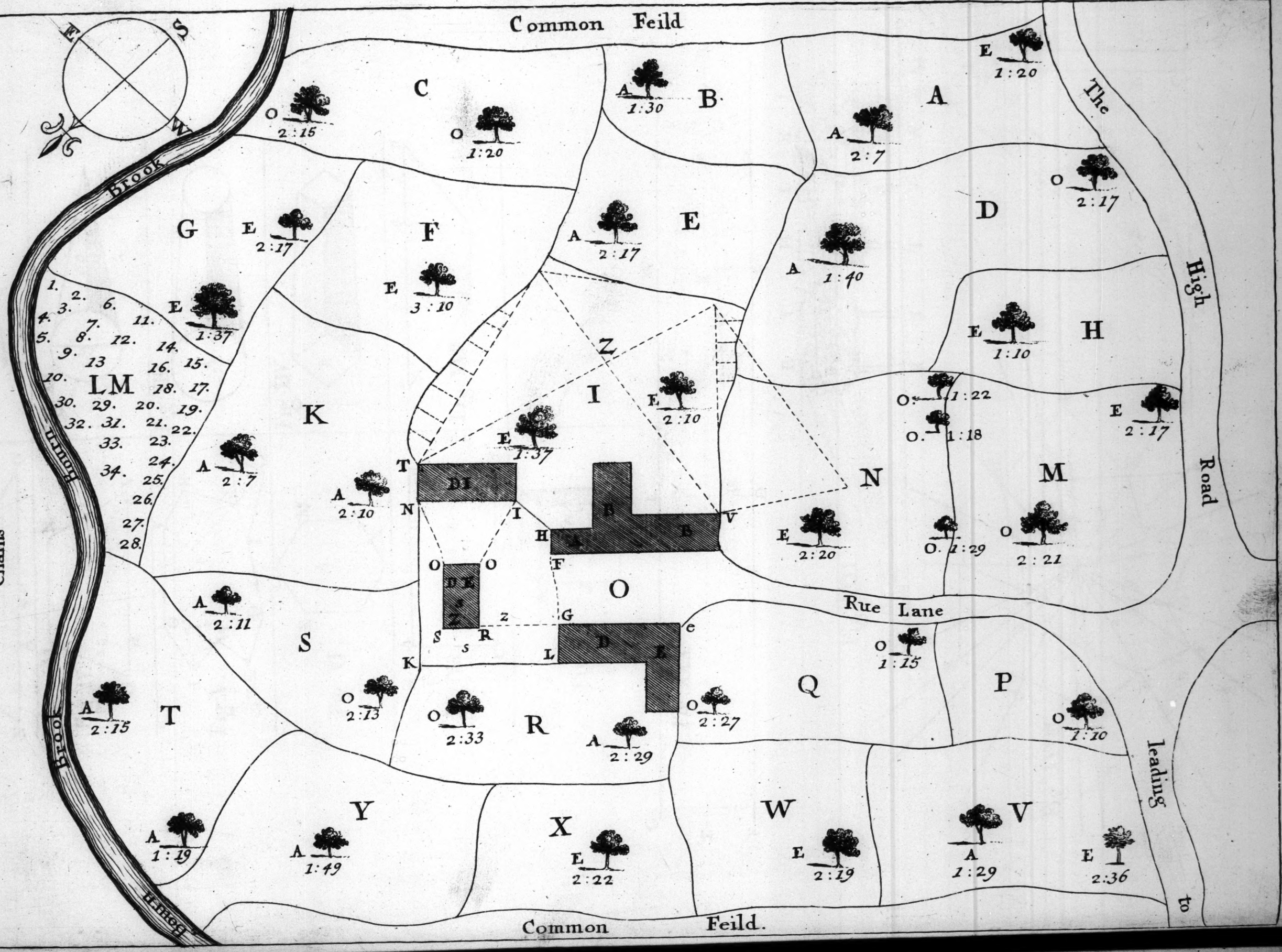
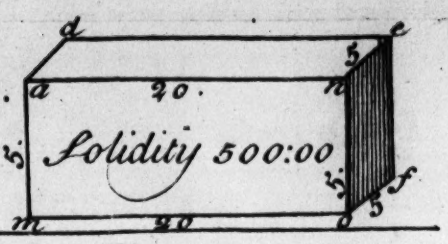


Fig: I.

Fig: X.



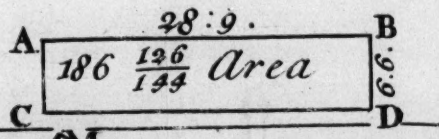
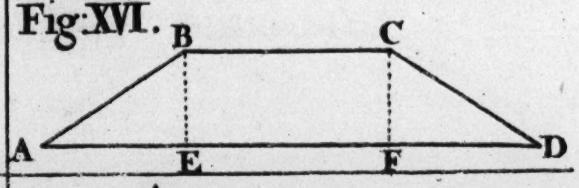


Fig: XVI.



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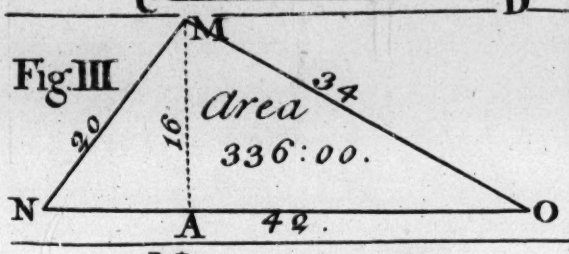

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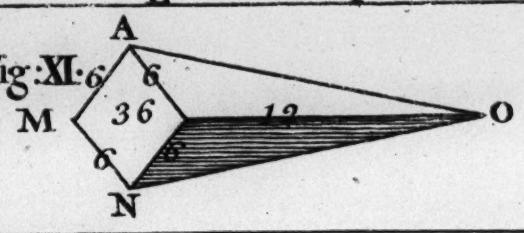

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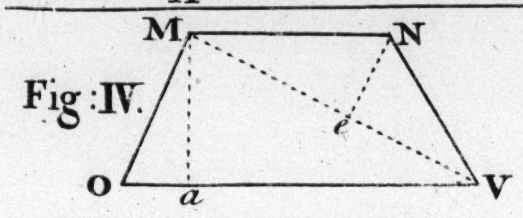

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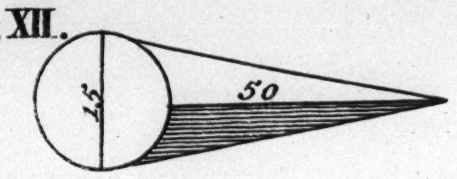

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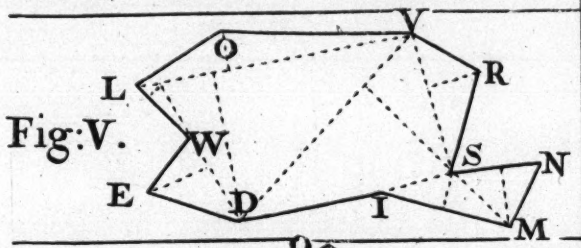

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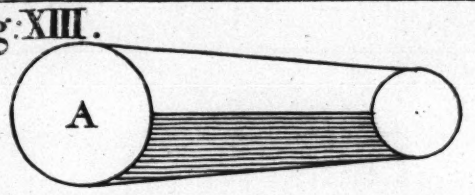

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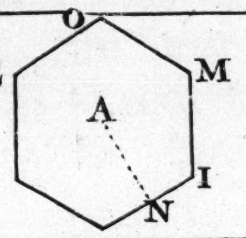

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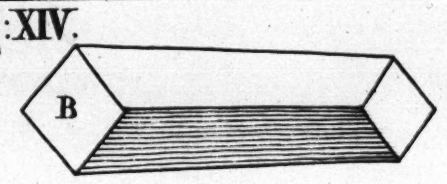

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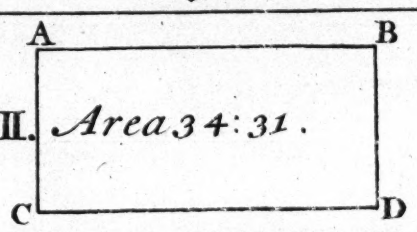

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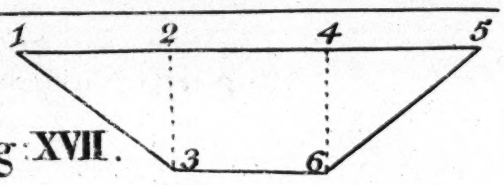


Fig: IX.

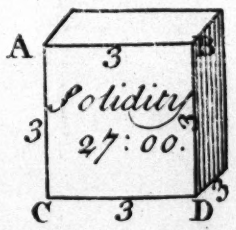


Fig: XXX.

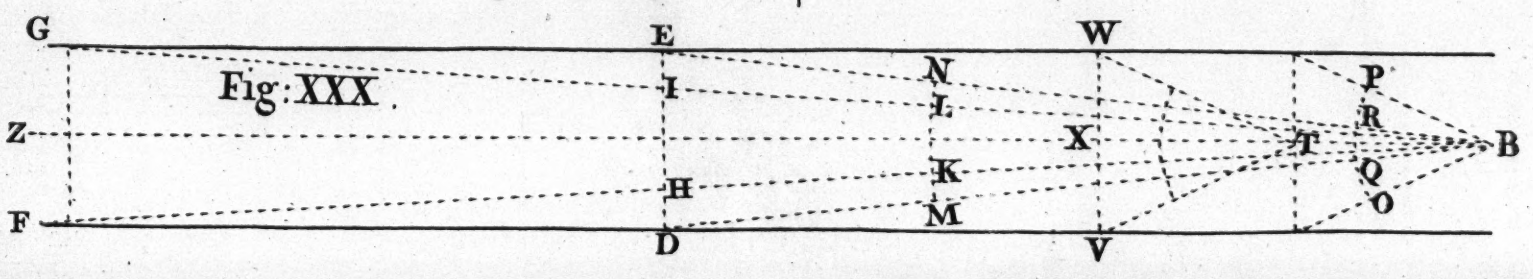


Fig: XXXI.

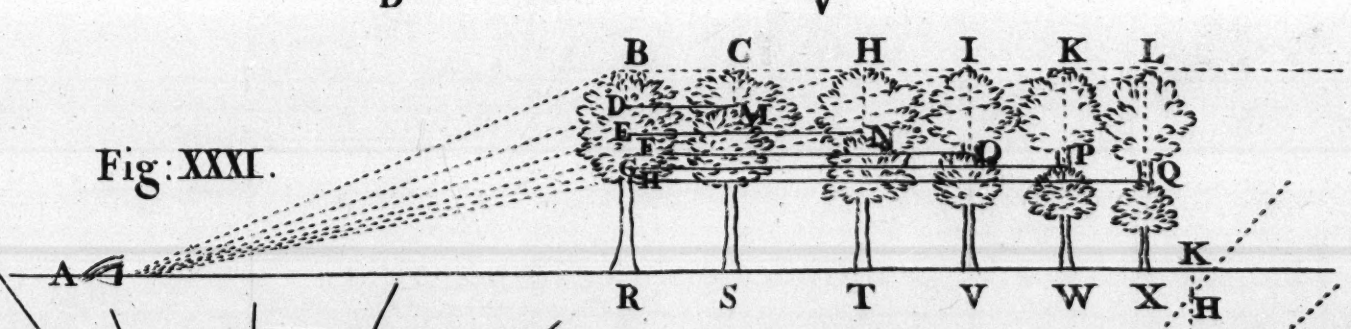
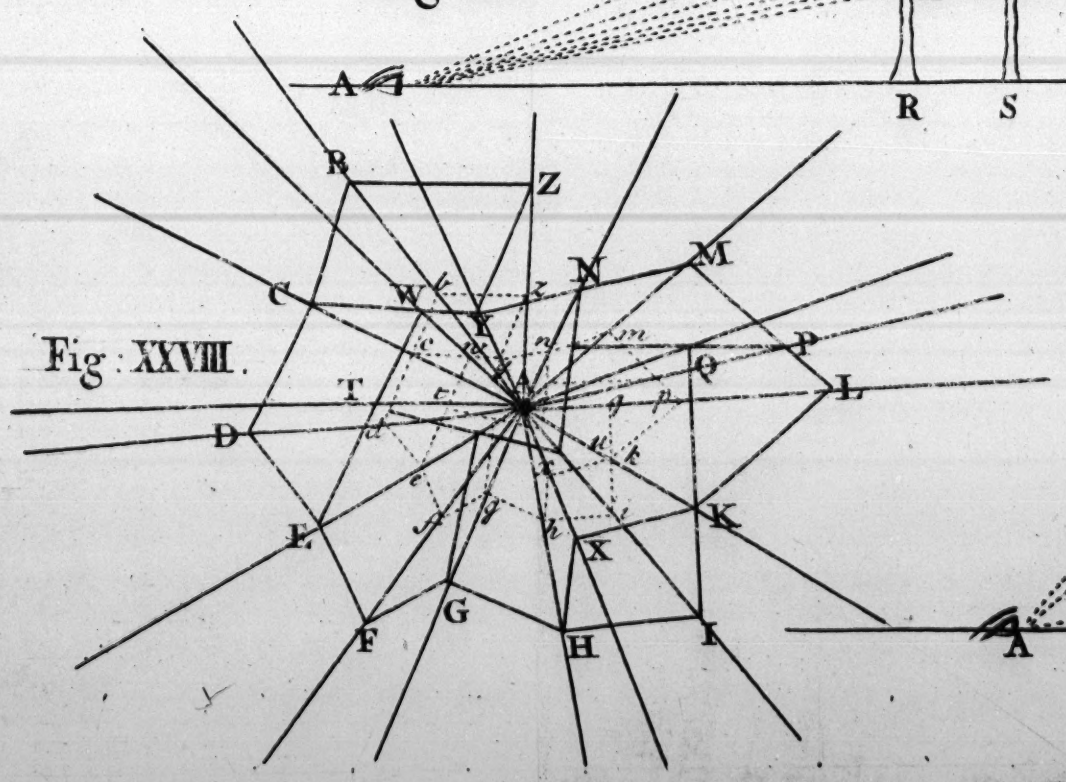


Fig: XXVIII.



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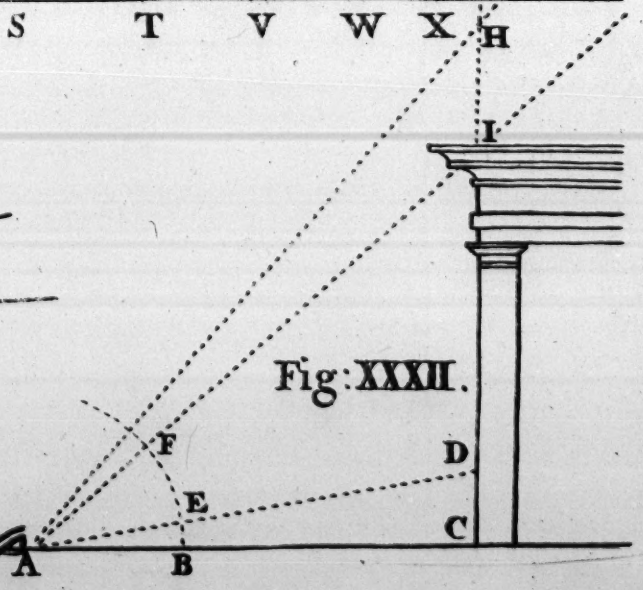


AN *Inspectional Table for y^e Mensuration of any Small Superficies, as Gilding with Gold, Silver &c. or of Plank, Glazing, Paving &c.*

The Dimensions Breadth in Inches.	Feet	Inches	10 parts
1	12	0	0
2	6	0	0
3	4	0	0
4	3	0	0
5	2	4	8
6	2	0	0
7	1	8	6
8	1	6	0
9	1	4	0
10	1	2	4
11	1	1	1
12	1	0	0
13	0	11	8
14	0	10	3
15	0	9	6
16	0	9	0
17	0	8	5
18	0	8	0
19	0	7	6
20	0	7	2
21	0	6	8
22	0	6	5
23	0	6	2
24	0	6	0
25	0	5	8
26	0	5	5
27	0	5	3
28	0	5	1
29	0	5	0
30	0	4	8
31	0	4	7
32	0	4	5
33	0	4	4
34	0	4	2
35	0	4	1
36	0	4	0

The length of one Foot.

An INSPECTIONAL TABLE *for y^e Mensuration of all Kinds of Superficies Measure, as Painting, Wainscoting, Plastering, Paving, Flooring, Glazing &c.*

The (Dimensions) Length in Feet.

The Dimensions Breadth in Inches.	1 Foot F. P.	2 Feet F. P.	3 Feet F. P.	4 Feet F. P.	5 Feet F. P.	6 Feet F. P.	7 Feet F. P.	8 Feet F. P.	9 Feet F. P.	10 Feet F. P.	11 Feet F. P.	12 Feet F. P.	13 Feet F. P.	14 Feet F. P.	15 Feet F. P.	16 Fe F. P.
1	0 8	0 16	0 25	0 32	0 40	0 50	0 58	0 66	0 75	0 84	0 92	1 0	1 8	1 16	1 25	1 33
2	0 7	0 34	0 50	0 68	0 85	1 0	1 16	1 36	1 50	1 70	1 84	2 0	2 16	2 33	2 50	2 66
3	0 25	0 56	0 75	1 0	1 25	1 50	1 75	2 0	2 25	2 50	2 75	3 0	3 25	3 49	3 75	4 0
4	0 33	0 66	1 0	1 32	1 65	2 0	2 32	2 65	3 0	3 30	3 66	4 0	4 33	4 65	5 0	5 33
5	0 42	0 84	1 25	1 68	2 10	2 50	2 90	3 36	3 75	4 20	4 58	5 0	5 42	5 81	6 25	7 66
6	0 50	1 0	1 50	2 0	2 50	3 0	3 50	4 0	4 50	5 0	5 50	6 0	6 50	7 0	7 50	8 0
7	0 58	1 16	1 75	2 32	2 90	3 50	4 6	4 65	5 25	5 80	6 42	7 0	7 58	8 16	8 75	9 33
8	0 67	1 34	2 0	2 68	3 35	4 0	4 69	5 36	6 0	6 70	7 33	8 0	8 66	9 33	10 0	10 66
9	0 75	1 50	2 25	3 0	3 85	4 50	5 25	6 0	6 75	7 50	8 25	9 0	9 75	10 49	11 25	12 0
10	0 82	1 66	2 50	3 32	4 15	5 0	5 81	6 65	7 50	8 30	9 16	10 0	10 84	11 65	12 50	13 33
11	0 92	1 84	2 75	3 68	4 60	5 50	6 44	7 36	8 25	9 20	10 8	11 0	11 92	12 81	13 75	14 66
12	1 0	2 0	3 0	4 0	5 0	6 0	7 0	8 0	9 0	10 0	11 0	12 0	13 0	14 0	15 0	16 0
13	1 8	2 16	3 25	4 32	5 40	6 50	7 56	8 65	9 75	10 80	11 92	13 0	14 8	15 16	16 25	17 33
14	1 17	2 34	3 50	4 68	5 85	7 0	8 19	9 36	10 50	11 70	12 84	14 0	15 16	16 33	17 50	18 66
15	1 25	2 50	3 75	5 0	6 25	7 50	8 75	10 0	11 25	12 50	13 75	15 0	16 25	17 49	18 75	20 0
16	1 33	2 66	4 0	5 82	6 65	8 0	9 31	10 65	12 0	13 30	14 66	16 0	17 33	18 65	20 0	21 33
17	1 42	2 84	4 25	5 68	7 10	8 50	9 94	11 36	12 75	14 20	15 58	17 0	18 42	20 81	21 25	22 66
18	1 50	3 0	4 50	6 0	7 50	9 0	10 50	12 0	13 50	15 0	16 50	18 0	19 50	21 0	22 50	24 0
19	1 58	3 16	4 75	6 82	7 90	9 50	11 6	12 65	14 25	15 80	17 42	19 0	20 58	23 16	23 75	25 33
20	1 67	3 34	5 0	6 68	8 35	10 0	11 69	13 36	15 0	16 70	18 33	20 0	21 66	24 33	25 0	26 66
21	1 75	3 50	5 25	7 0	8 85	10 50	12 25	14 0	15 75	17 50	19 25	21 0	22 75	25 49	26 25	28 0
22	1 83	3 66	5 50	7 32	9 15	11 0	12 81	14 65	16 50	18 30	20 16	22 0	23 84	26 65	27 50	29 33
23	1 92	3 84	5 75	7 68	9 60	11 50	13 44	15 36	17 25	19 20	21 8	23 0	24 92	27 81	28 75	30 66
24	2 0	4 0	6 0	8 0	10 0	12 0	14 0	16 0	18 0	20 0	22 0	24 0	26 0	29 0	30 0	32 0
25	2 8	4 16	6 25	8 32	10 40	12 50	14 56	16 65	18 75	20 80	22 92	25 0	27 8	30 16	31 25	33 33
26	2 17	4 34	6 50	8 68	10 85	13 0	15 19	17 36	19 50	21 70	23 84	26 0	28 16	31 33	32 50	34 66
27	2 25	4 50	6 75	9 0	11 25	13 50	15 75	18 0	20 25	22 50	24 75	27 0	29 25	32 49	33 75	36 0
28	2 33	4 66	7 0	9 32	11 65	14 0	16 31	18 65	21 0	23 30	25 66	28 0	30 33	33 65	35 0	37 33
29	2 42	4 84	7 25	9 68	12 10	14 50	16 94	19 36	21 75	24 20	26 58	29 0	31 42	34 81	36 25	38 66
30	2 50	5 0	7 50	10 0	12 50	15 0	17 50	20 0	22 50	25 0	27 50	30 0	32 50	36 0	37 50	40 0
31	2 58	5 16	7 75	10 82	12 90	15 50	18 6	20 65	23 25	25 80	28 42	31 0	33 58	37 16	38 75	41 33
32	2 67	5 34	8 0	10 68	13 35	16 0	18 69	21 36	24 0	26 70	29 33	32 0	34 66	38 33	40 0	42 66
33	2 75	5 50	8 25	11 0	13 85	16 50	19 25	22 0	24 75	27 50	30 25	33 0	35 75	39 49	41 25	44 0
34	2 83	5 66	8 50	11 32	14 15	17 0	19 81	22 65	25 50	28 30	31 16	34 0	36 84	40 65	42 50	45 33
35	2 92	5 84	8 75	11 68	14 60	17 50	20 44	23 36	26 25	29 20	32 8	35 0	37 92	41 81	43 75	46 66
36	3 0	6 0	9 0	12 0	15 0	18 0	21 0	24 0	27 0	30 0	33 0	36 0	39 0	42 0	45 0	48 0

TABLE V.

A TABLE OF MEAN PROPORTIONALS for reducing unequall sided Timber (as most is,) Stone &c. to true Square Measure, as Table IV.

Sides of the Square in Inches.		Sides of the Square in Inches.		Sides of the Square in Inches.	
1	000000	34	153147	67	182607
2	030103	35	154406	68	183250
3	047712	36	155630	69	183845
4	060206	37	156820	70	184509
5	069897	38	157978	71	185125
6	077815	39	159106	72	185735
7	084509	40	160205	73	186332
8	090308	41	161278	74	186923
9	095424	42	162325	75	187506
10	100000	43	163346	76	188081
11	104139	44	164345	77	188649
12	107918	45	165321	78	189209
13	111394	46	166275	79	189762
14	114612	47	167209	80	190309
15	117609	48	168124	81	190848
16	120411	49	169019	82	191381
17	123044	50	168897	83	191907
18	125527	51	170757	84	192428
19	127875	52	171600	85	192941
20	130102	53	172427	86	193449
21	132221	54	173239	87	193952
22	134242	55	174036	88	194448
23	136172	56	174818	89	194939
24	138021	57	175587	90	195424
25	139794	58	176342	91	195904
26	141497	59	177058	92	196378
27	143136	60	177815	93	196848
28	144715	61	178533	94	197312
29	146239	62	179239	95	197772
30	147712	63	179934	96	198227
31	149136	64	180618	97	198677
32	150515	65	181291	98	199122
33	151851	66	181954	99	199563
				100	200000

TABLE VI.

An INSPECTIONAL TABLE.

Shewing how much in Length will make a Solid Foot, of any round Timber Stone &c. according to any Girt or Circumference given in Inches.

Inches	The Girt. Feet	Inch^s	Parts	Inches	The Girt. Feet	Inch^s	Parts	Inches	The Girt. Inch^s	Parts
10	18	11	2	40	1	1	6	70	4	4
11	14	11	5	41	1	0	9	71	4	3
12	12	6	8	42	1	0	3	72	4	2
13	10	8	5	43	0	11	7	73	4	1
14	9	2	7	44	0	11	1	74	3	4
15	7	10	3	45	0	10	7	75	3	4
16	7	0	3	46	0	10	2	76	3	3
17	6	3	8	47	0	9	9	77	3	3
18	5	7	0	48	0	9	4	78	3	3
19	5	4	6	49	0	8	8	79	3	3
20	4	6	1	50	0	8	4	80	3	3
21	4	1	8	51	0	7	9	81	3	3
22	3	8	4	52	0	7	5	82	3	3
23	3	4	1	53	0	7	1	83	3	3
24	3	1	8	54	0	6	8	84	3	3
25	2	10	8	55	0	6	4	85	3	2
26	2	8	5	56	0	6	1	86	2	2
27	2	6	3	57	0	5	9	87	2	2
28	2	4	1	58	0	5	6	88	2	2
29	2	2	0	59	0	5	3	89	2	2
30	2	0	0	60	0	5	0	90	2	2
31	1	10	0	61	0	4	9	91	2	2
32	1	9	7	62	0	4	6	92	2	2
33	1	7	6	63	0	4	4	93	2	2
34	1	6	5	64	0	4	2	94	2	2
35	1	5	4	65	0	4	0	95	2	2
36	1	4	3	66	0	3	9	96	2	2
37	1	3	3	67	0	3	7	97	2	2
38	1	3	2	68	0	3	5	98	2	2
39	1	2	3	69	0	3	3	99	2	2
								100	2	2

The Length of a Foot.

The Length of a Foot.

The Length of a Foot.

TABLE VII.

Perch	¼ Parts	The Breadth of the Land. 1 Rood P.	P.
1	0	40	80
	1	36	64
	2	26	52
	3	22	44
2	0	20	40
	1	17	35
	2	16	32
	3	14	29
3	0	13	26
	1	12	24
	2	11	22
	3	10	21
4	0	10	20
	1	9	18
	2	8	17
	3	8	16
5	0	8	16
	1	7	14
	2	7	14
	3	6	13
6	0	6	12
	1	6	12
	2	6	11
	3	5	11
7	0	5	10
	1	5	10
	2	5	10
	3	5	9
8	0	4	9
	1	4	8
	2	4	8
	3	4	8
9	0	4	8
	1	4	7
	2	3	7
	3	3	7
10	0	3	6
	1	3	6
	2	3	6
	3	3	6
11	0	3	6
	1	3	5
	2	3	5
	3	3	5
12	0	2	5
	1	2	5
	2	2	5
	3	2	4
13	0	2	4
	1	2	4
	2	2	4
	3	2	4
14	0	2	4
	1	2	4
	2	2	3
	3	2	3
15	0	2	3
	1	2	3
	2	2	3
	3	2	3
16	0	2	3
	1	2	3
	2	2	3
	3	2	3
17	0	2	3
	1	2	3
	2	2	3
	3	2	3
18	0	2	3
	1	2	3
	2	2	3
	3	2	3
19	0	2	3
	1	2	3
	2	2	3
	3	2	3
20	0	2	3
	1	2	3
	2	2	3
	3	2	3

The Breadth of the Land.

...PERFICIAL, ...square foot Measure.

	17 Feet		18 Feet		19 Feet		20 Feet	
	F.	P.	F.	P.	F.	P.	F.	P.
33	1	42	1	50	1	58	1	66
66	2	84	3	0	3	16	3	32
0	4	26	4	50	4	74	5	0
33	5	68	6	0	6	32	6	66
66	7	10	7	50	7	90	8	32
0	8	50	9	0	9	50	10	0
33	9	92	10	50	11	8	11	66
66	11	34	12	0	12	66	13	32
0	12	76	13	50	14	24	15	0
33	14	18	15	0	15	82	16	66
66	15	60	16	50	17	40	18	32
0	17	0	18	0	19	0	20	0
33	18	42	19	50	20	58	21	66
66	19	84	21	0	22	16	23	32
0	21	26	22	50	23	74	25	0
33	22	68	24	0	25	32	26	66
66	24	10	25	50	26	90	28	32
0	25	50	27	0	28	48	30	0
33	26	92	28	50	30	6	31	66
66	28	34	30	0	31	64	33	32
0	29	76	31	50	33	22	35	0
33	31	18	33	0	34	80	36	66
66	32	60	34	50	36	38	38	32
0	34	0	36	0	38	0	40	0
33	35	42	37	50	39	58	41	66
66	36	84	39	0	41	16	43	32
0	38	26	40	50	42	74	45	0
33	39	68	42	0	44	32	46	66
66	39	10	43	50	45	90	48	32
0	41	50	45	0	47	48	50	0
33	43	92	46	50	49	6	51	66
66	44	34	48	0	50	64	53	32
0	45	76	49	50	52	22	55	0
33	47	18	51	0	53	80	56	66
66	48	60	52	50	55	38	58	32
0	51	0	54	0	57	0	60	0

An Inspectional Table

Shewing how much in Length will make a Solid foot of any True Squared Timber, Stone &c.

Inches square at y^e end of y^e Stone, Timber &c.	Feet	Inches	Parts
6	4	0	0
7	2	11	2
8	2	3	0
9	1	9	3
10	1	3	3
11	1	2	3
12	1	0	0
13	0	10	2
14	0	8	8
15	0	7	6
16	0	6	7
17	0	5	9
18	0	5	3
19	0	4	8
20	0	4	3
21	0	3	9
22	0	3	5
23	0	3	2
24	0	3	0
25	0	2	8
26	0	2	6
27	0	2	3
28	0	2	2
29	0	2	1
30	0	1	9
31	0	1	8
32	0	1	7
33	0	1	6
34	0	1	5
35	0	1	4
36	0	1	3

The Length of a Solid Foot.

An INSPECTIONAL TABLE for the Mensuration of Timber, Stone &c. as is Exactly Square at each end Calculated from 1 Inch Square, to 36, and for any length required.

Inch's square at y^e end of y^e Stone, Timber &c.	The Length of the Timber, Stone &c. 1 Feet		2 Feet		3 Feet		4 Feet		5 Feet		6 Feet		7 Feet		8 Feet		9 Feet		10 Feet	
	F.	P.	F.	P.	F.	P.	F.	P.	F.	P.	F.	P.	F.	P.	F.	P.	F.	P.	F.	P.
1	0	1	0	1	0	2	0	3	0	3	0	4	0	5	0	5	0	6	0	7
2	0	3	0	5	0	8	0	11	0	14	0	17	0	19	0	22	0	25	0	28
3	0	6	0	12	0	18	0	25	0	31	0	37	0	43	0	49	0	56	0	62
4	0	11	0	22	0	33	0	44	0	55	0	66	0	78	0	89	1	0	1	11
5	0	17	0	35	0	52	0	69	0	87	1	4	1	22	1	39	1	56	1	74
6	0	25	0	50	0	75	1	0	1	25	1	50	1	55	2	0	2	25	2	50
7	0	34	0	68	1	2	1	36	1	70	2	4	2	38	2	72	3	6	3	40
8	0	44	0	89	1	33	1	77	2	22	2	66	3	11	3	55	4	0	4	44
9	0	50	1	12	1	68	2	25	2	81	3	37	3	93	4	49	5	6	5	62
10	0	69	1	39	2	8	2	77	3	47	4	16	4	86	5	55	6	24	6	94
11	0	84	1	68	2	52	3	36	4	20	5	4	5	88	6	72	7	56	8	40
12	1	0	2	0	3	0	4	0	5	0	6	0	7	0	8	0	9	0	10	0
13	1	18	2	35	3	52	4	69	5	87	7	4	8	22	9	39	10	56	11	74
14	1	36	2	72	4	8	5	44	6	80	8	16	9	53	10	89	12	25	13	61
15	1	56	3	12	4	68	6	25	7	81	9	37	10	93	12	49	14	6	15	62
16	1	78	3	55	5	33	7	11	8	89	10	67	12	44	14	22	16	0	17	78
17	2	1	4	10	6	2	8	3	10	3	12	4	14	5	16	5	18	6	20	7
18	2	25	4	50	6	75	9	0	11	23	13	56	15	75	19	0	20	25	22	50
19	2	51	5	1	7	52	10	3	12	53	15	4	17	55	20	5	22	56	25	7
20	2	78	5	55	8	33	11	11	13	89	16	67	19	40	22	22	25	0	27	78
21	3	6	6	13	9	18	12	25	15	31	18	37	21	43	24	49	27	56	30	62
22	3	36	6	72	10	8	13	44	16	80	20	16	23	53	26	89	30	25	33	61
23	3	67	7	34	11	3	14	69	18	36	22	4	25	71	29	38	33	6	36	73
24	4	0	8	0	12	0	16	0	20	0	24	0	28	0	32	0	36	0	40	0
25	4	34	8	68	13	2	17	36	21	70	26	4	30	38	34	76	39	2	43	40
26	4	69	9	39	14	8	18	77	23	47	28	16	32	86	37	55	42	24	47	0
27	5	6	10	12	15	19	20	25	25	31	30	38	35	44	40	50	45	57	50	63
28	5	44	10	89	16	33	21	78	27	22	32	67	38	11	43	56	49	0	54	45
29	5	84	11	68	17	52	23	36	29	20	35	4	40	88	46	72	52	56	58	40
30	6	25	12	50	18	75	25	0	31	25	37	50	43	75	50	0	56	25	62	50
31	6	67	13	34	20	2	27	0	33	36	40	4	46	71	53	38	60	6	66	73
32	7	11	14	22	21	33	28	44	35	55	42	66	49	78	56	89	64	0	71	11
33	7	56	15	15	22	68	30	24	37	81	45	37	52	93	60	49	68	6	75	62
34	8	3	16	5	24	8	32	11	40	14	48	17	56	19	64	22	72	25	80	28
35	8	50	17	1	25	52	34	3	42	53	51	4	59	55	68	5	76	56	85	7
36	9	0	18	0	27	0	36	0	46	0	54	0	63	0	72	0	81	0	90	0

VII. An INSPECTIONAL TABLE of LAND MEASURE Shewing the Superficial Content of any quantity of Land. As also, How to Divide Lands in Common Feilds or Inclosures, According to any Proportion Assigned.

The Breadth of the Land. Perch & Parts	The Length of 1 Rood P.	pts.	2 Rood P.	pts.	3 Rood P.	pts.	One Acre P.	pts.
	80	0	120	0	160	0		
	64	0	96	0	128	0		
	52	50	78	75	105	0		
	44	22	68	58	88	44		
	40	0	60	0	80	0		
	35	64	53	46	71	28		
	32	0	48	0	64	0		
	29	8	43	62	58	16		
	26	66	30	0	53	33		
	24	66	37	0	49	32		
	22	86	34	29	45	72		
	21	32	31	98	42	64		
	20	0	30	0	40	0		
	18	82	28	23	37	64		
	17	76	26	64	35	52		
	16	84	25	26	33	68		
	16	0	24	0	32	0		
	15	24	22	86	30	48		
	14	54	21	81	29	8		
	13	90	20	81	27	80		
	13	33	19	98	26	66		
	12	80	19	20	25	60		
	12	32	18	48	24	64		
	11	84	17	76	23	68		
	11	42	17	28	22	85		
	11	4	16	56	22	8		
	10	61	16	0	21	32		
	10	32	15	48	20	64		
	10	0	15	0	20	0		
	9	70	14	55	19	40		
	9	40	14	10	18	80		
	8	14	13	71	16	28		
	8	88	13	32	17	77		
	8	64	12	96	17	28		
	8	42	12	63	16	84		
	8	20	12	30	16	40		
	8	0	12	0	16	0		
	7	78	11	67	15	56		
	7	67	11	43	15	24		
	7	44	11	16	14	88		

The Breadth of the Land. Perch & Parts	The Length of 1 Rood P.	pts.	2 Rood P.	pts.	3 Rood P.	pts.	One Acre P.	pts.
11 0	3	63	7	27	10	89	14	54
1	3	55	7	10	10	65	14	20
2	3	47	6	94	10	41	13	88
3	3	40	6	80	10	20	13	60
12 0	3	33	6	66	10	0	13	33
1	3	26	6	52	9	76	13	4
2	3	20	6	40	9	60	12	80
3	3	13	6	26	9	39	12	52
13 0	3	8	6	15	9	24	12	31
1	3	2	6	4	9	6	12	8
2	2	96	5	92	8	88	11	84
3	2	90	5	80	8	70	11	60
14 0	2	85	5	70	8	55	11	42
1	2	80	5	60	8	40	11	20
2	2	75	5	50	8	25	11	0
3	2	71	5	42	8	13	10	84
15 0	2	66	5	33	7	98	10	66
1	2	62	5	24	7	86	10	48
2	2	58	5	16	7	74	10	32
3	2	54	5	8	7	62	10	16
16 0	2	50	5	0	7	50	10	0
1	2	46	4	92	7	38	9	84
2	2	42	4	84	7	26	9	68
3	2	38	4	76	7	14	9	52
17 0	2	35	4	72	7	5	9	42
1	2	32	4	64	6	96	9	28
2	2	28	4	56	6	84	9	12
3	2	25	4	50	6	75	9	0
18 0	2	22	4	45	6	66	8	89
1	2	19	4	39	6	57	8	78
2	2	16	4	32	6	48	8	64
3	2	13	4	26	6	89	8	52
19 0	2	10	4	21	6	30	8	42
1	2	8	4	16	6	24	8	32
2	2	5	4	16	6	15	8	20
3	2	3	4	6	6	9	8	12
20 0	2	0	4	0	6	0	8	0
1	1	97	3	94	5	91	7	88
2	1	94	3	88	5	82	7	76
3	1	92	3	84	5	76	7	68

The Breadth of the Land. Perch & Parts	The Length of 1 Rood P.	pts.	2 Rood P.	pts.	3 Rood P.	pts.	One Acre P.	pts.
21 0	1	90	3	81	5	70	7	62
1	1	98	3	76	5	64	7	52
2	1	86	3	72	5	58	7	44
3	1	83	3	66	5	49	7	32
22 0	1	82	3	63	5	46	7	27
1	1	79	3	58	5	37	7	16
2	1	77	3	54	5	31	7	8
3	1	75	3	50	5	25	7	0
23 0	1	73	3	46	5	19	6	95
1	1	71	3	43	5	13	6	86
2	1	70	3	40	5	10	6	80
3	1	68	3	36	5	4	6	72
24 0	1	66	3	33	4	98	6	66
1	1	64	3	28	4	92	6	56
2	1	63	3	26	4	89	6	52
3	1	61	3	22	4	83	6	44
25 0	1	60	3	20	4	80	6	40
1	1	58	3	16	4	74	6	32
2	1	56	3	12	4	68	6	24
3	1	54	3	8	4	62	6	16
26 0	1	53	3	7	4	59	6	12
1	1	52	3	4	4	56	6	8
2	1	51	3	2	4	53	6	4
3	1	49	2	98	4	47	5	96
27 0	1	47	2	94	4	41	5	92
1	1	46	2	92	4	38	5	84
2	1	45	2	90	4	35	5	80
3	1	43	2	86	4	29	5	72
28 0	1	42	2	84	4	26	5	71
1	1	41	2	82	4	23	5	64
2	1	40	2	80	4	20	5	60
3	1	39	2	78	4	17	5	56
29 0	1	38	2	76	4	14	5	52
1	1	37	2	73	4	11	5	46
2	1	35	2	70	4	5	5	40
3	1	34	2	68	4	2	5	36
30 0	1	33	2	66	4	0	5	33
1	1	32	2	64	3	96	5	28
2	1	31	2	62	3	93	5	24
3	1	30	2	60	3	90	5	20

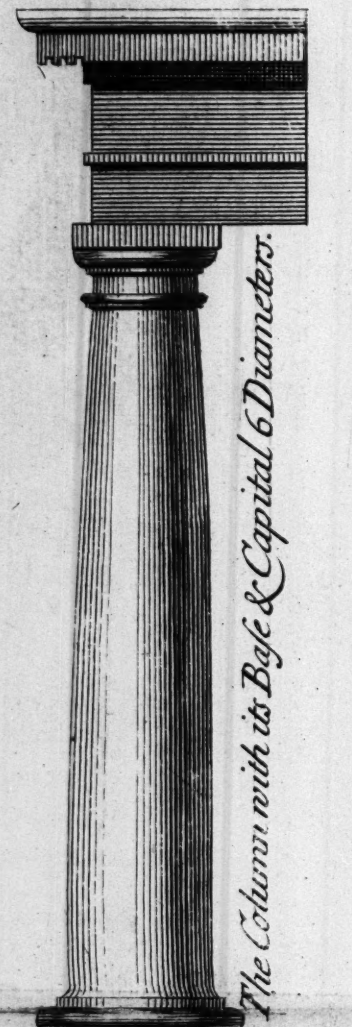
The Breadth of the Land. Perch & Parts	The Length of 1 Rood P.	pts.	2 Rood P.	pts.	3 Rood P.	pts.	One Acre P.	pts.
31 0	1	29	2	57	3	87	5	16
1	1	28	2	56	3	84	5	12
2	1	27	2	54	3	81	5	8
3	1	26	2	52	3	78	5	4
32 0	1	25	2	50	3	75	5	0
1	1	24	2	48	3	72	4	96
2	1	23	2	46	3	69	4	92
3	1	22	2	44	3	66	4	88
33 0	1	21	2	42	3	63	4	85
1	1	20	2	40	3	60	4	80
2	1	19	2	38	3	57	4	76
3	1	18	2	36	3	54	4	72
34 0	1	17	2	35	3	52	4	70
1	1	17	2	34	3	50	4	68
2	1	16	2	33	3	49	4	66
3	1	16	2	32	3	48	4	64
35 0	1	15	2	30	3	45	4	60
1	1	14	2	28	3	42	4	56
2	1	12	2	24	3	36	4	48
3	1	11	2	22	3	33	4	44
36 0	1	10	2	21	3	31	4	42
1	1	10	2	20	3	30	4	40
2	1	9	2	19	3	27	4	38
3	1	9	2	18	3	25	4	36
37 0	1	8	2	16	3	24	4	32
1	1	7	2	14	3	21	4	30
2	1	6	2	12	3	18	4	28
3	1	5	2	10	3	15	4	24
38 0	1	5	2	10	3	15	4	21
1	1	4	2	9	3	12	4	18
2	1	4	2	8	3	12	4	15
3	1	3	2	6	3	9	4	12
39 0	1	2	2	4	3	6	4	8
1	1	1	2	2	3	4	4	4
2	1	0	2	2	3	3	4	3
3	1	0	2	1	3	2	4	1
40 0	1	0	2	0	3	0	4	0

Profiles of the TUSCAN Order, According to the Proportions of

VIGNOLA.

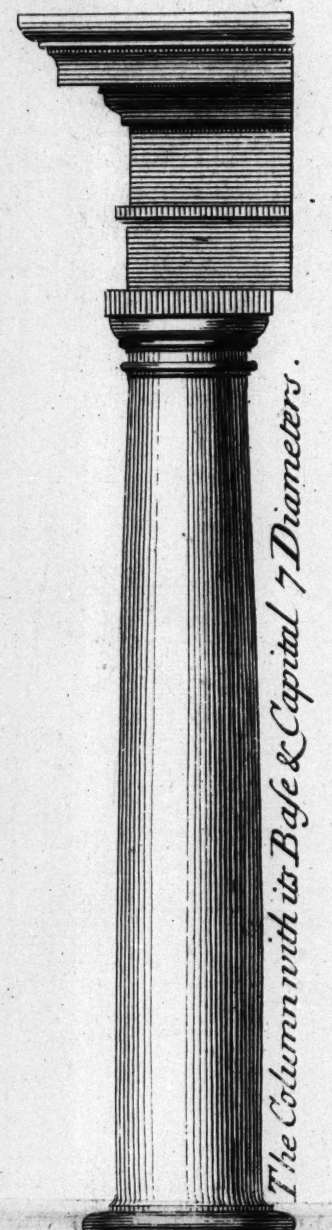
The Column with its Base & Capital 7 Diameters.

S. SERLIO.



The Column with its Base & Capital 6 Diameters.

VITRUVIUS.



The Column with its Base & Capital 7 Diameters.

SCAMOZZI.

The Column with its Base & Capital 7 Diam. $\frac{1}{2}$.

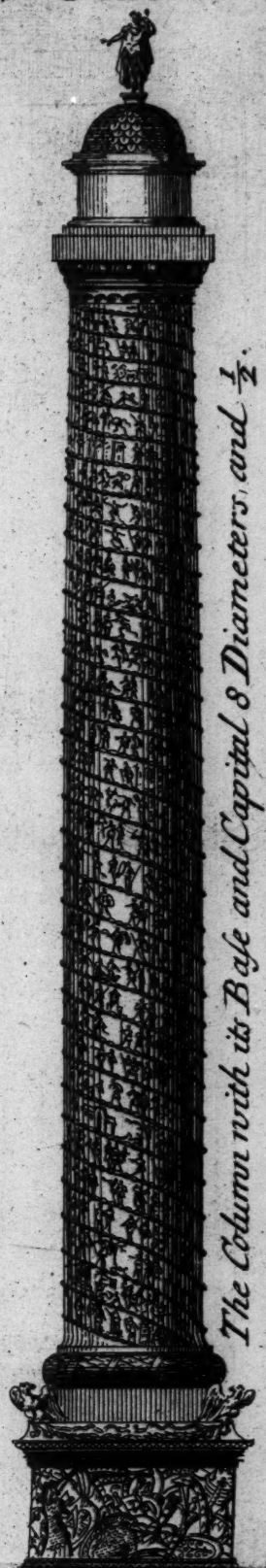
PALLADIO.

The Column with its Base & Capital 7 Diameters.

LE CLERC.

The Column with its Base & Capital 7 Diameters.

TRAJANS COLUMN.



The Column with its Base and Capital 8 Diameters and $\frac{1}{2}$.

The Column with its Base & Capital 7 Diameters.

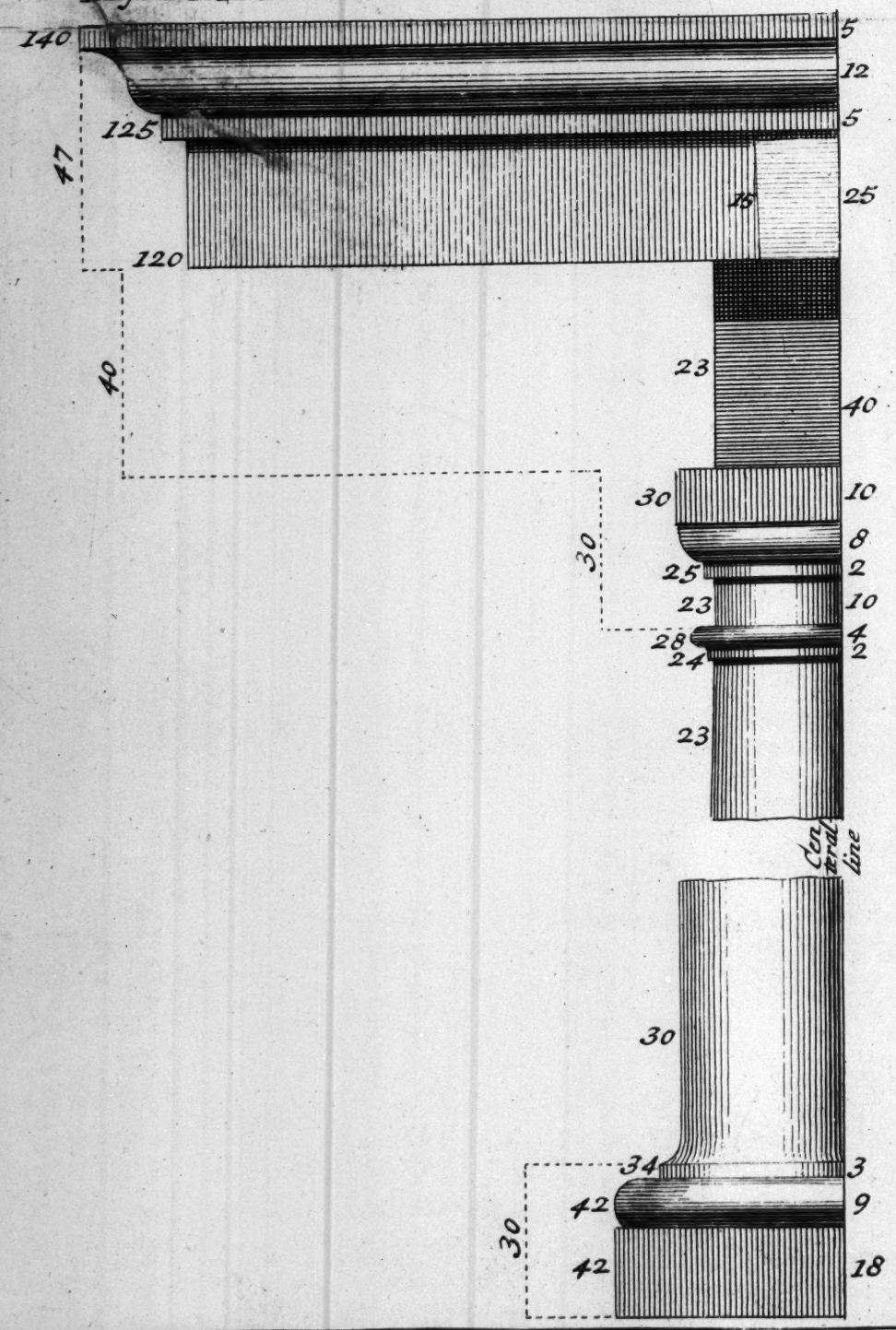
The Column with its Base & Capital 7 Diameters.

The Column with its Base & Capital 7 Diam: & ½.

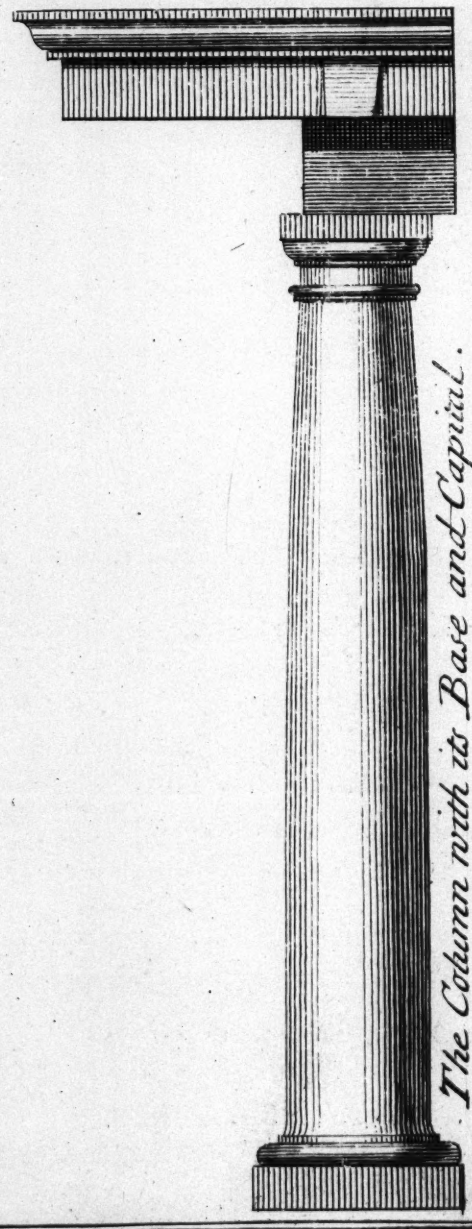
PERRAULT.

The Column with its Base & Capital 7 Diam: & ½.

INEGO IONES
in y^e Grand Portico of S^t. Pauls Covent Garden.



INEGO IONES in the Grand Portico of S^t. Pauls Covent Garden.



The Column with its Base and Capital.

M. ANGELO.

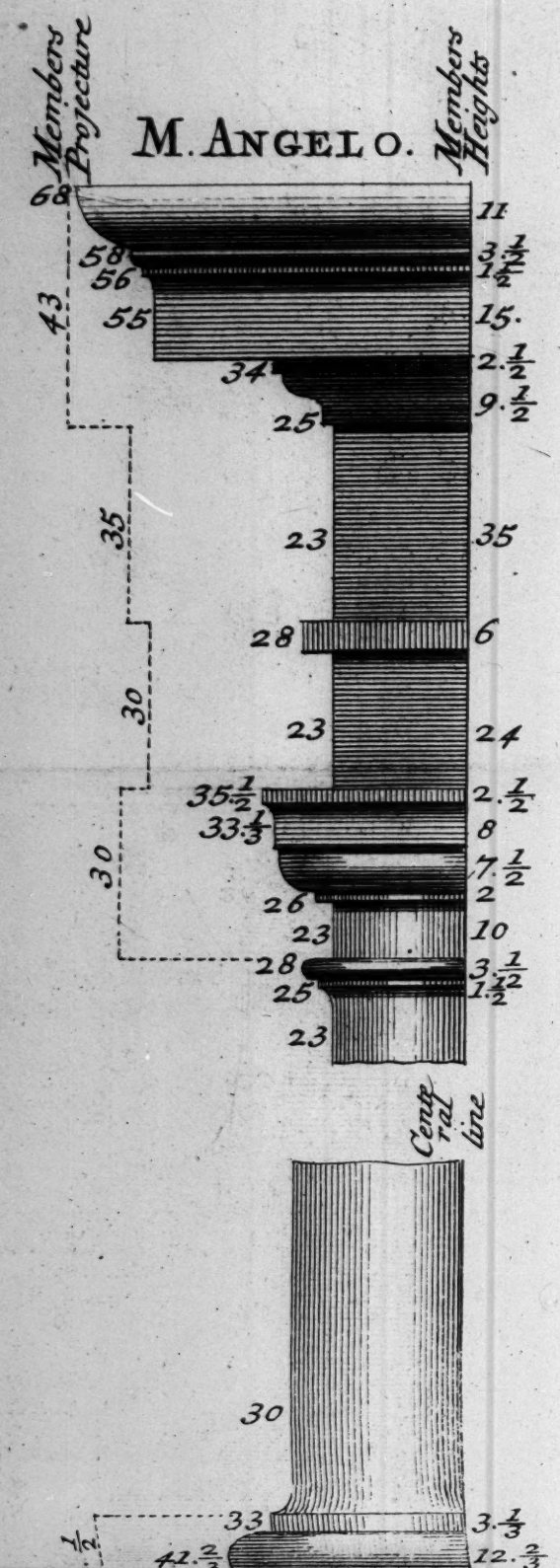
The Column with its Base & Capital 7 Diameters.

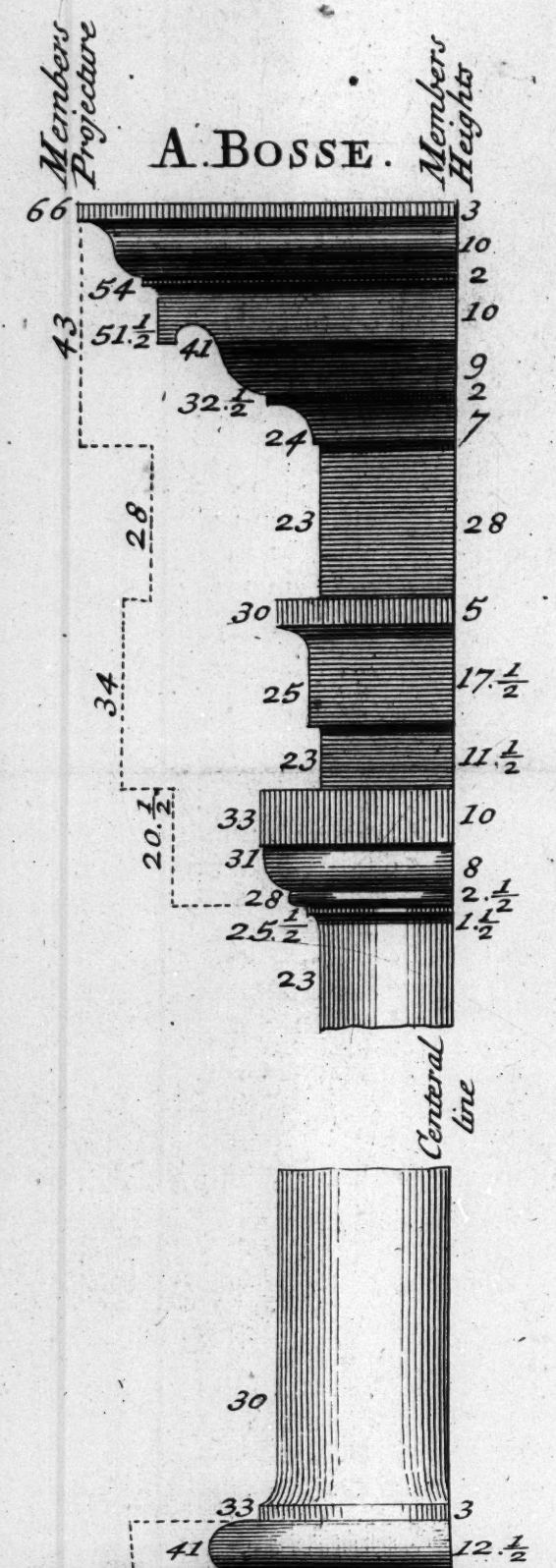
A. BOSSE.

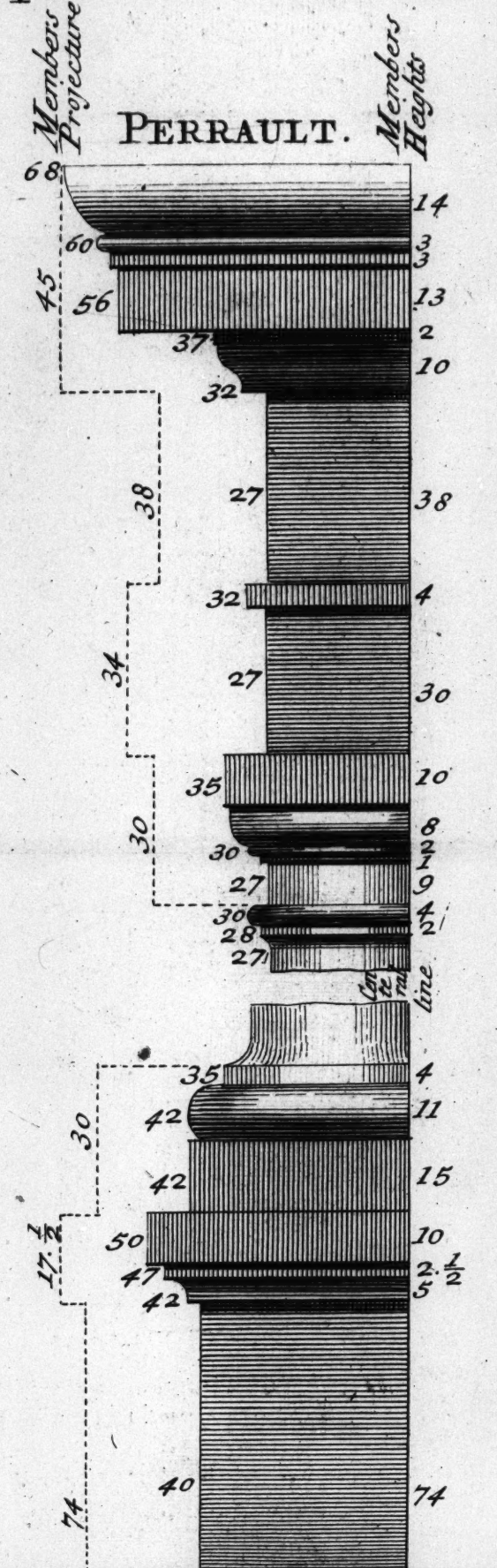
The Column with its Base & Capital 7 Diam: & ½.

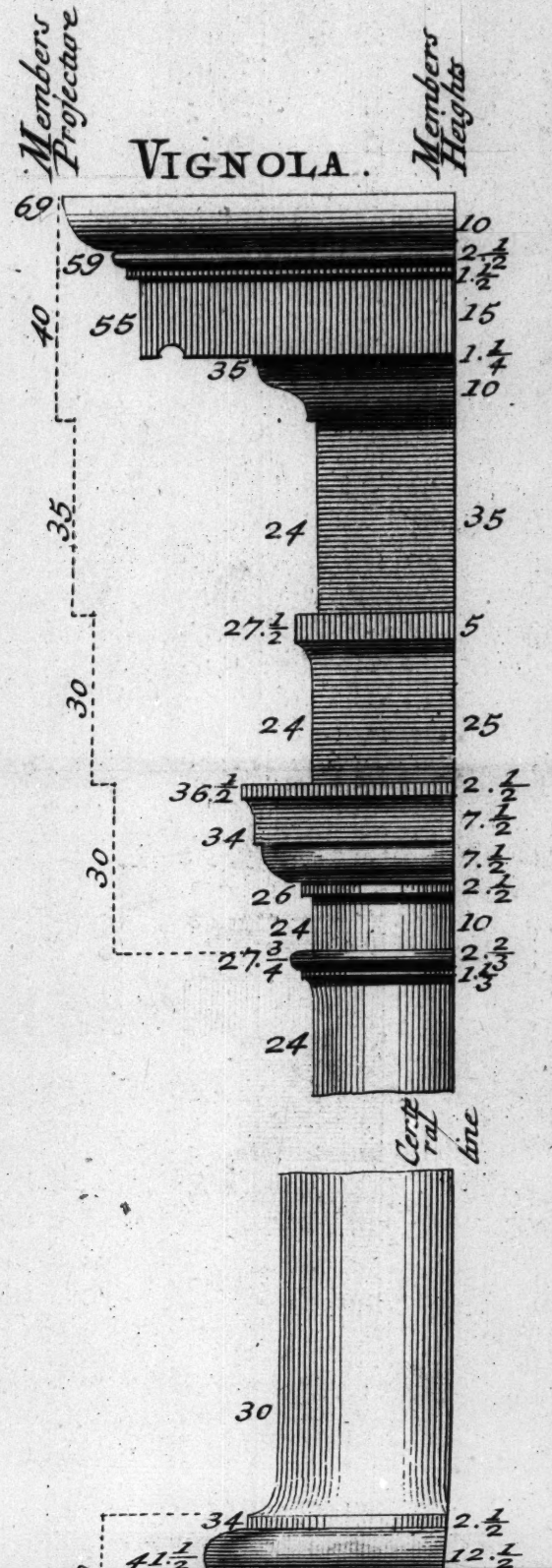
Plate XIX

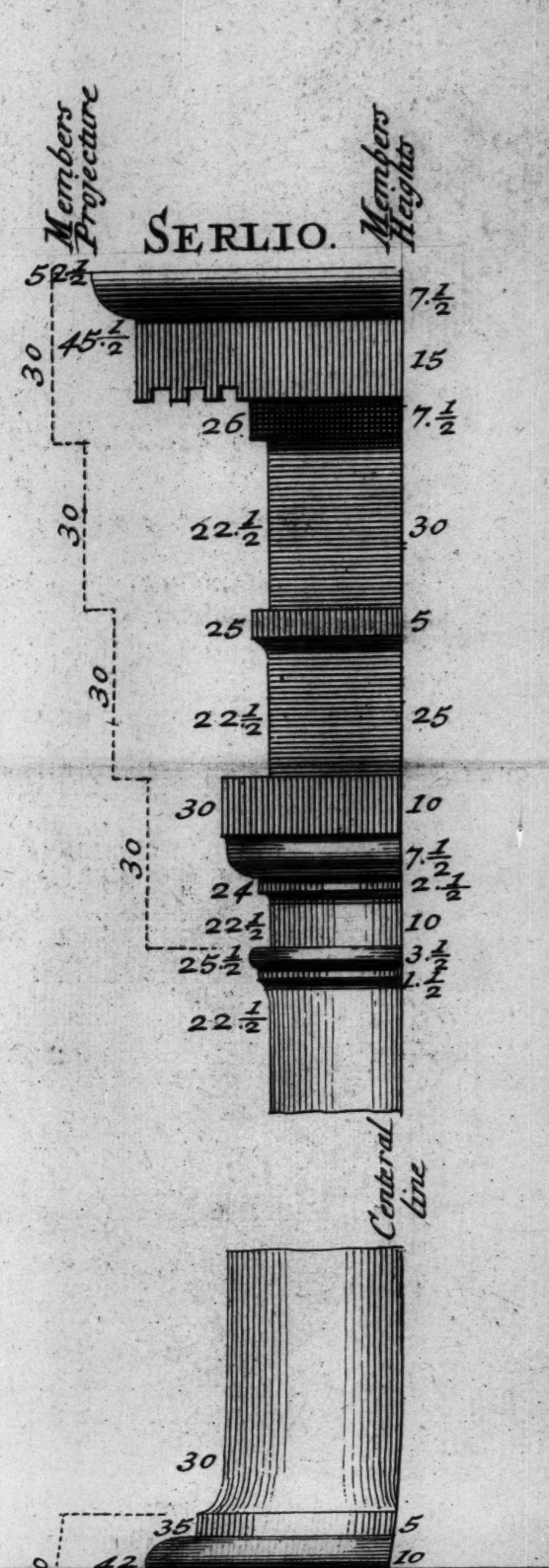
Geometrical Elevations of $\frac{c}{y}$ TUSCAN Base, Capital and Entablature. According to the Proportions of —



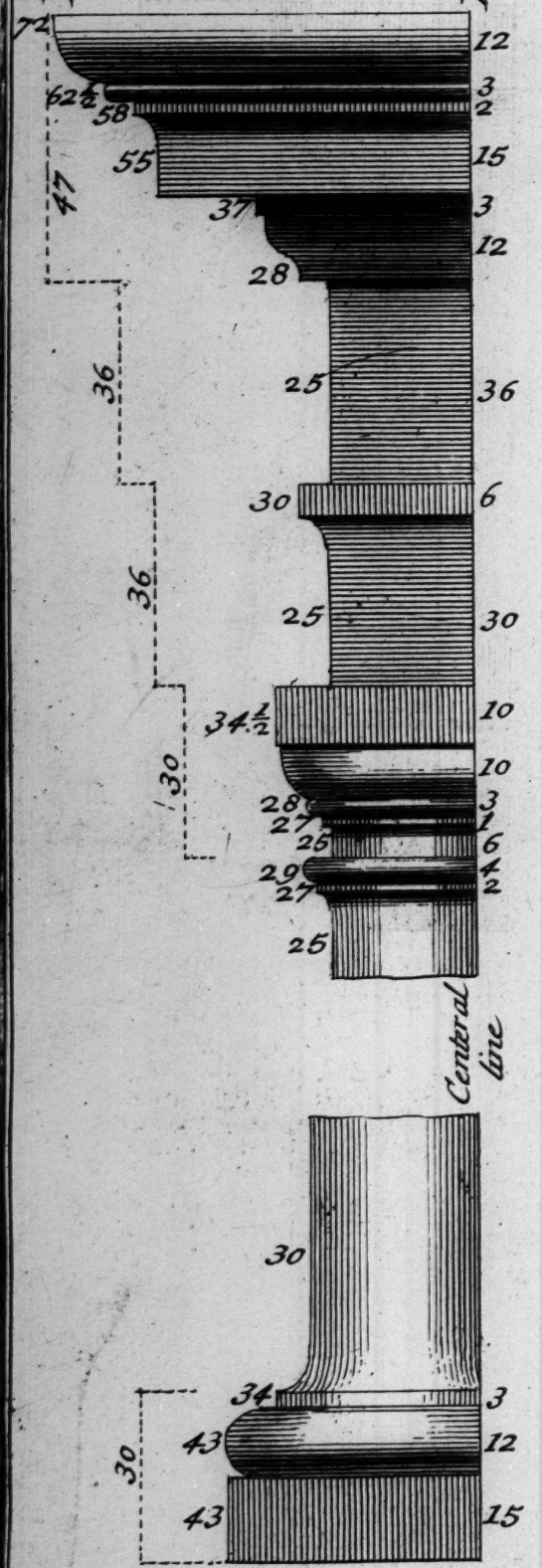




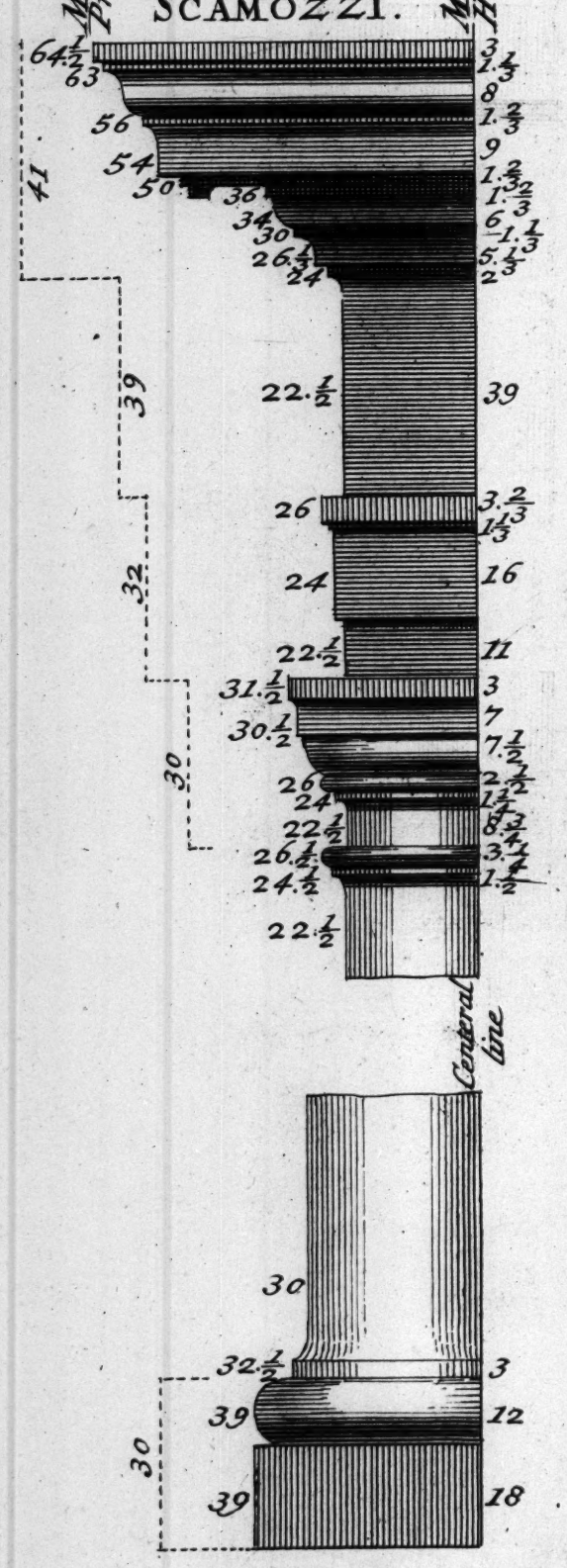




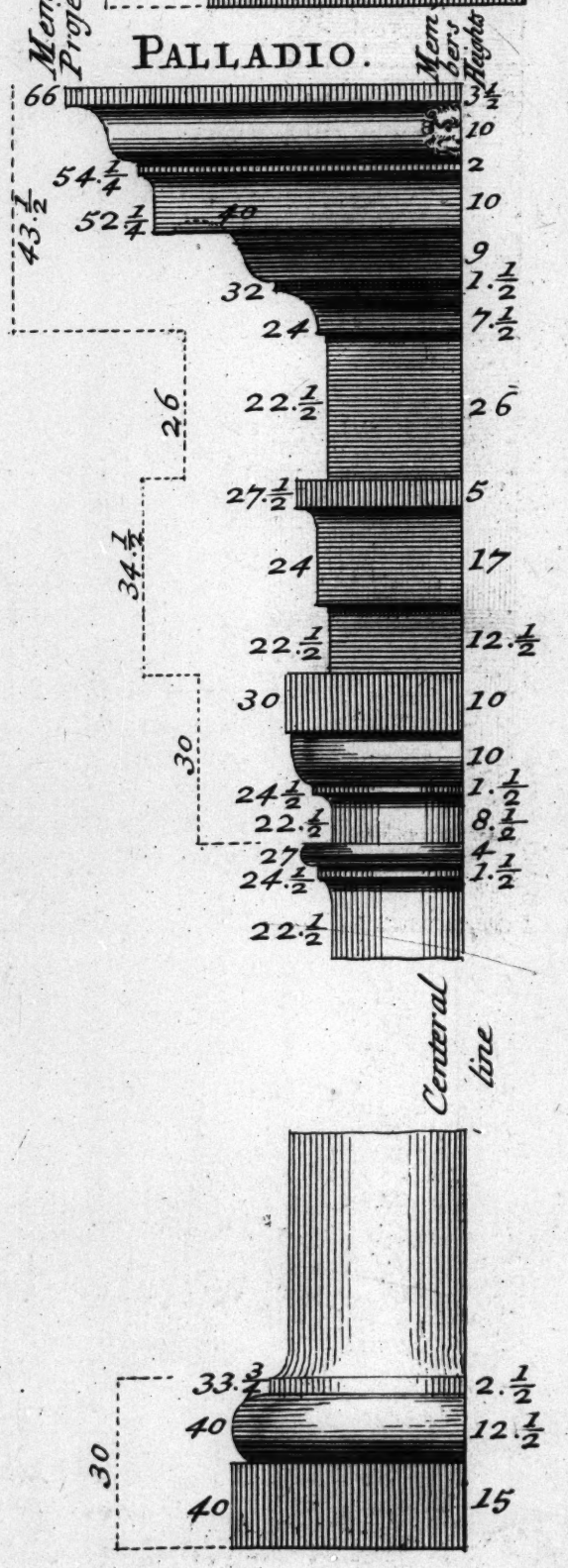
Vitruvius.



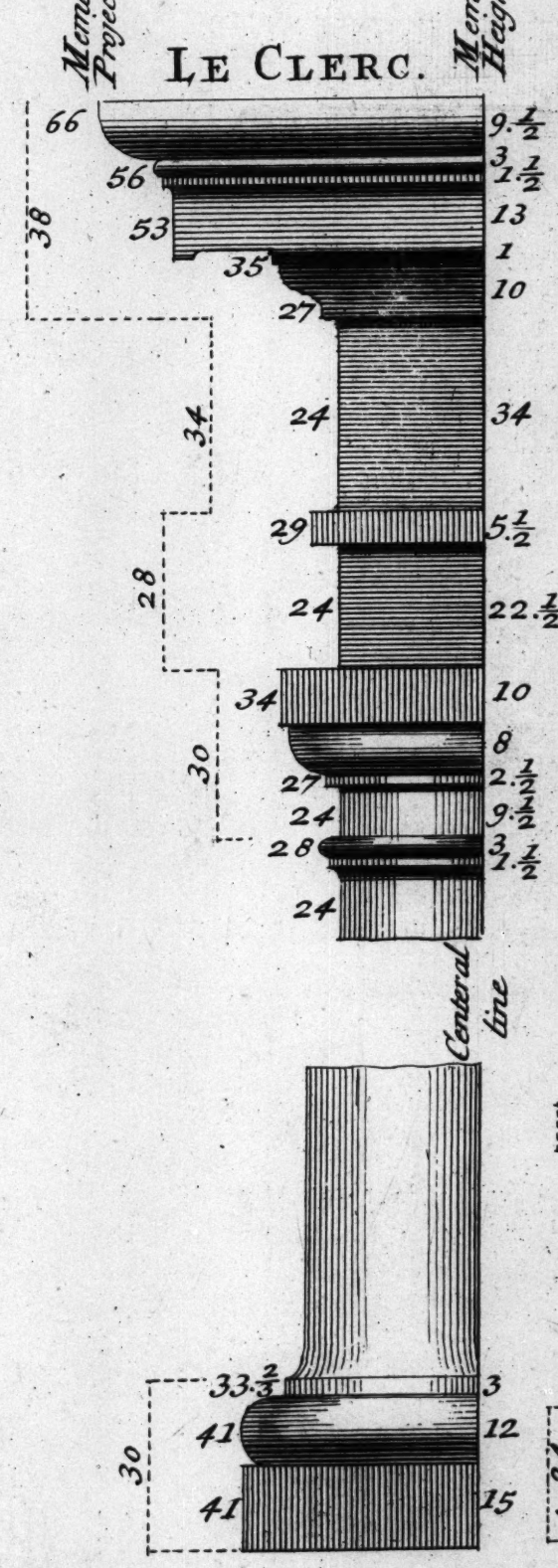
Scamozzi.



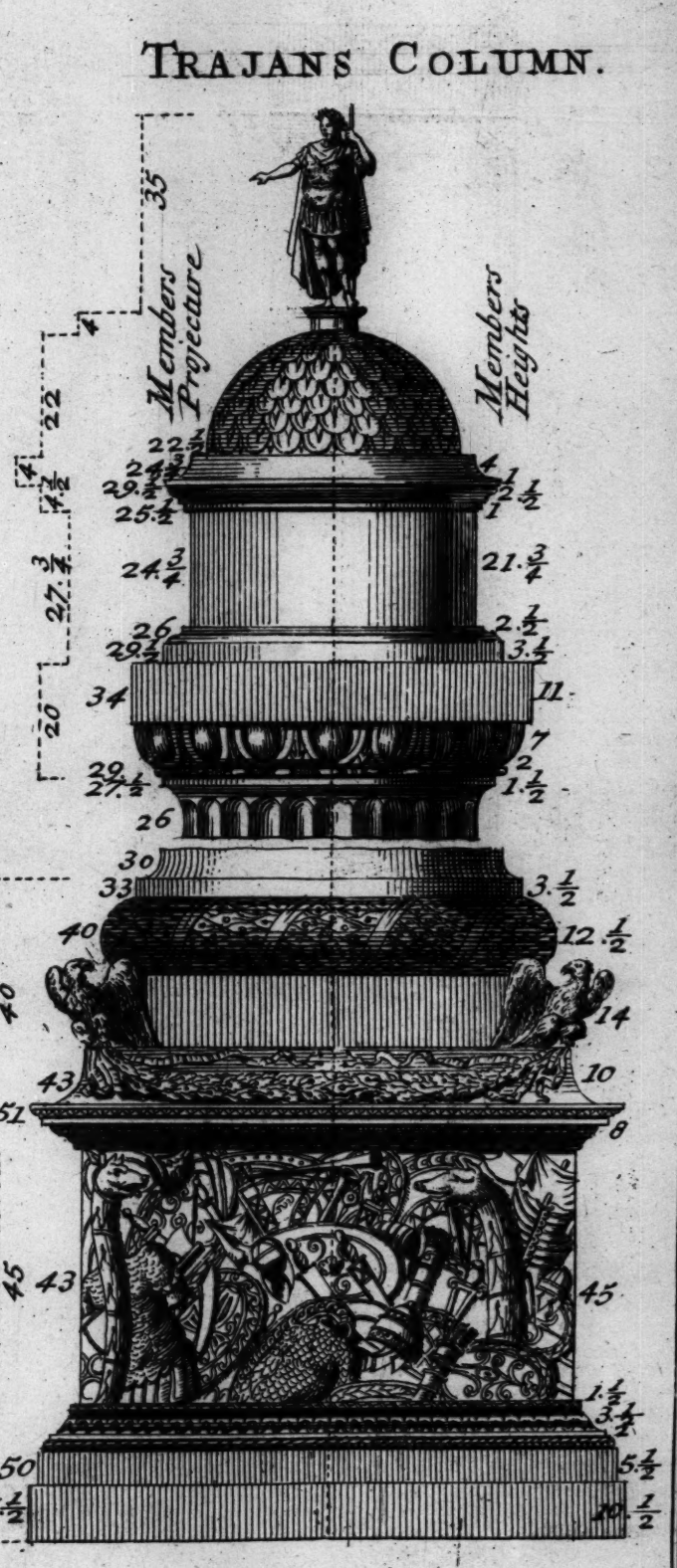
Palladio.



Le Clerc.



Trajans Column.



PROFILES OF THE DORICK ORDER

taken from according to the Proportions of

The Theatre of MARCELLUS in ROME.

The Shaft and Capital 8 Diameters high

The Bath of DIOCLETIAN in ROME.

The Shaft and Capital 7 Diameters and ½

ALBANE near ROME.

The Column with its Base and Capital 7 Diameters and ½

VITRUVIUS.

The Column with its Base & Capital 8 Diameters & sometimes 8 and ½

PALLADIO.

The Column with its Base and Capital 8 Diameters and ½

SCAMOZZI.

The Column Base and Capital 7 Diameters

SERLIO.

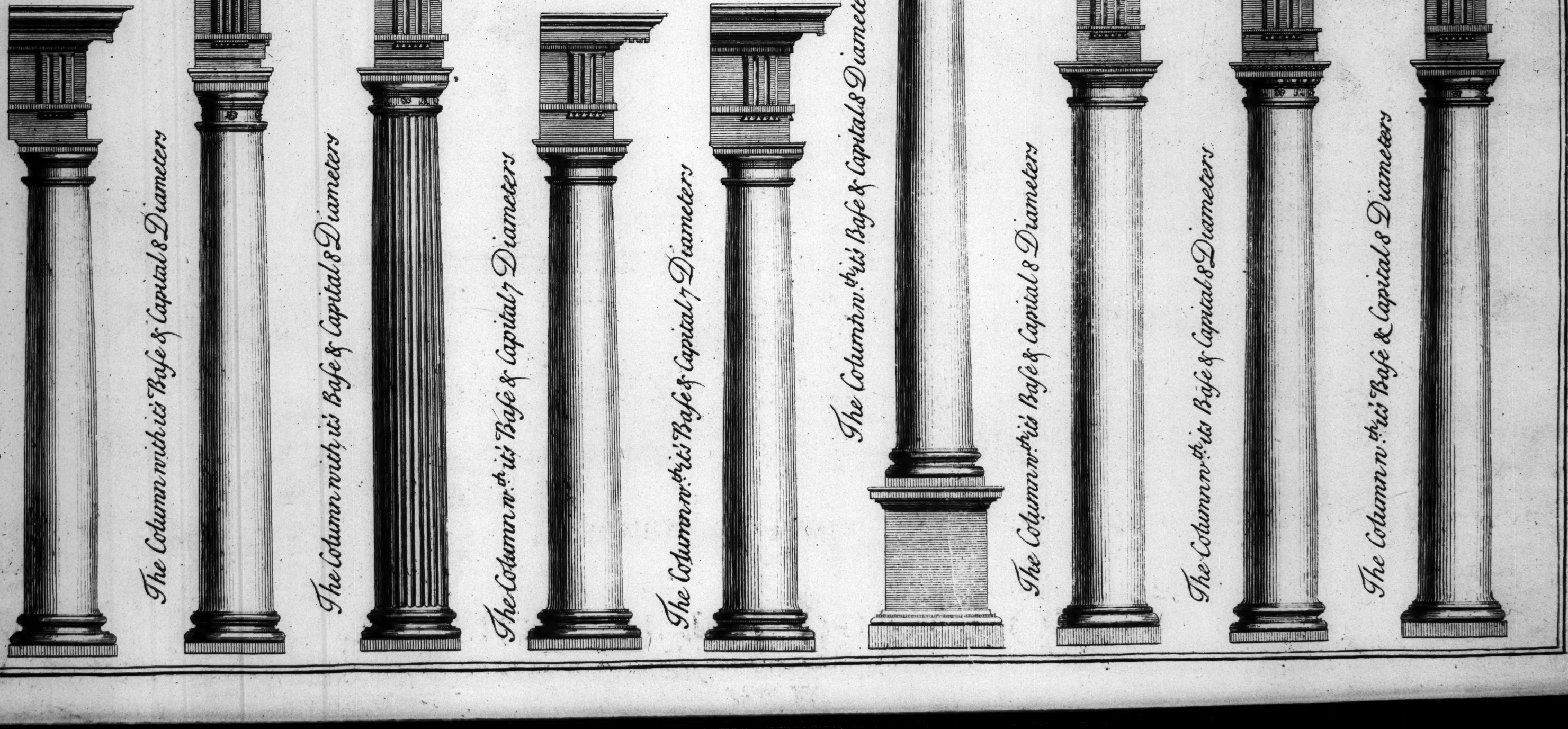
The Column Base and Capital 8 Diameters

VIGNOLA.

The Column Base and Capital 7 Diameters

D. BARBARO

CATANEO. L.B.ALBERTI. VIOLA. I.BULLANT. DE LORME. PERRAULT. LE CLERC. A.BOSSE. M.ANGELO.



The Column Base and Capital 7 Diameters

The Column with it's Base & Capital 8 Diameters

The Column with it's Base & Capital 8 Diameters

The Column nr.th it's Base & Capital 7 Diameters

The Column nr.th it's Base & Capital 7 Diameters

The Column nr.th it's Base & Capital 7 Diameters

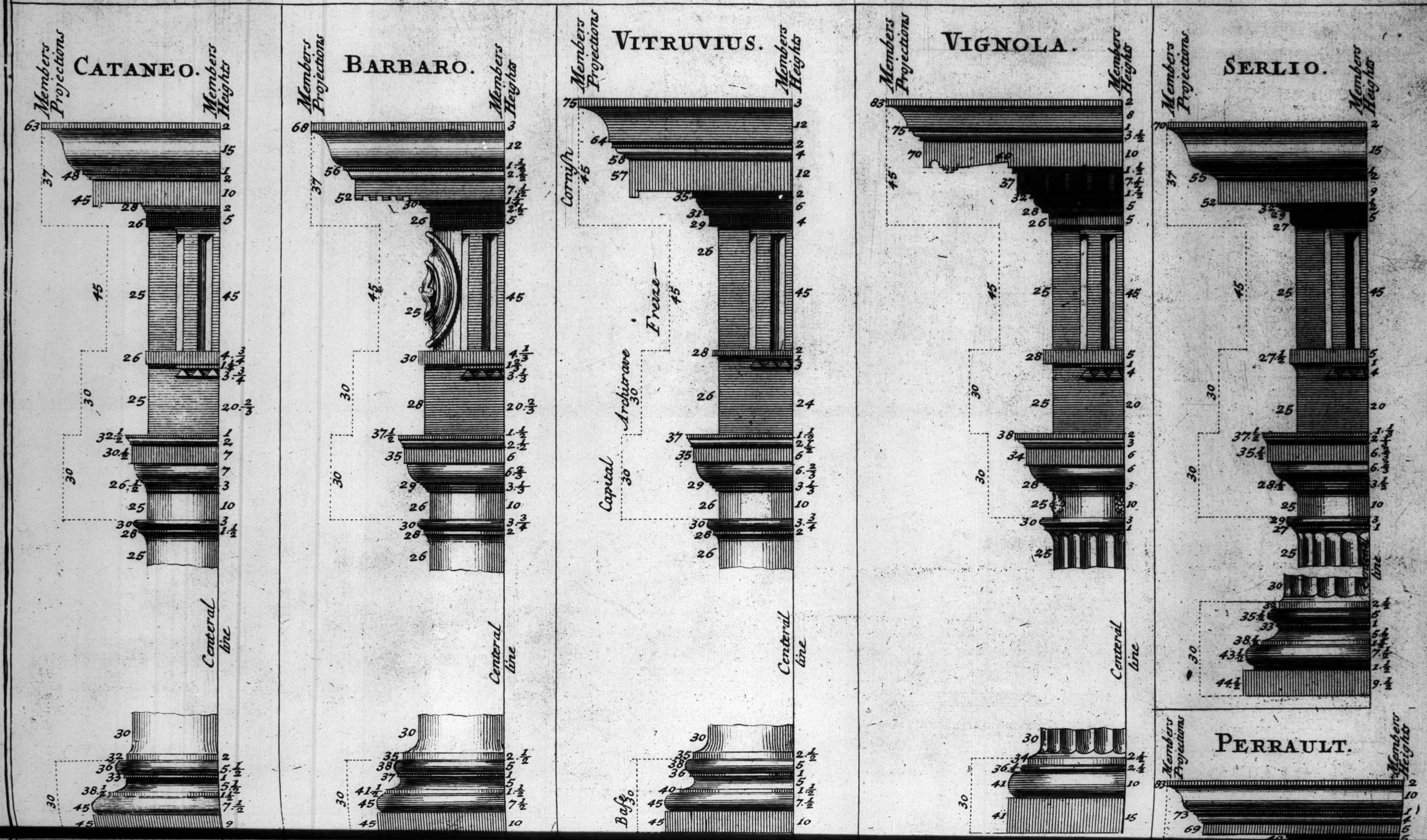
The Column nr.th it's Base & Capital 8 Diameters

The Column nr.th it's Base & Capital 8 Diameters

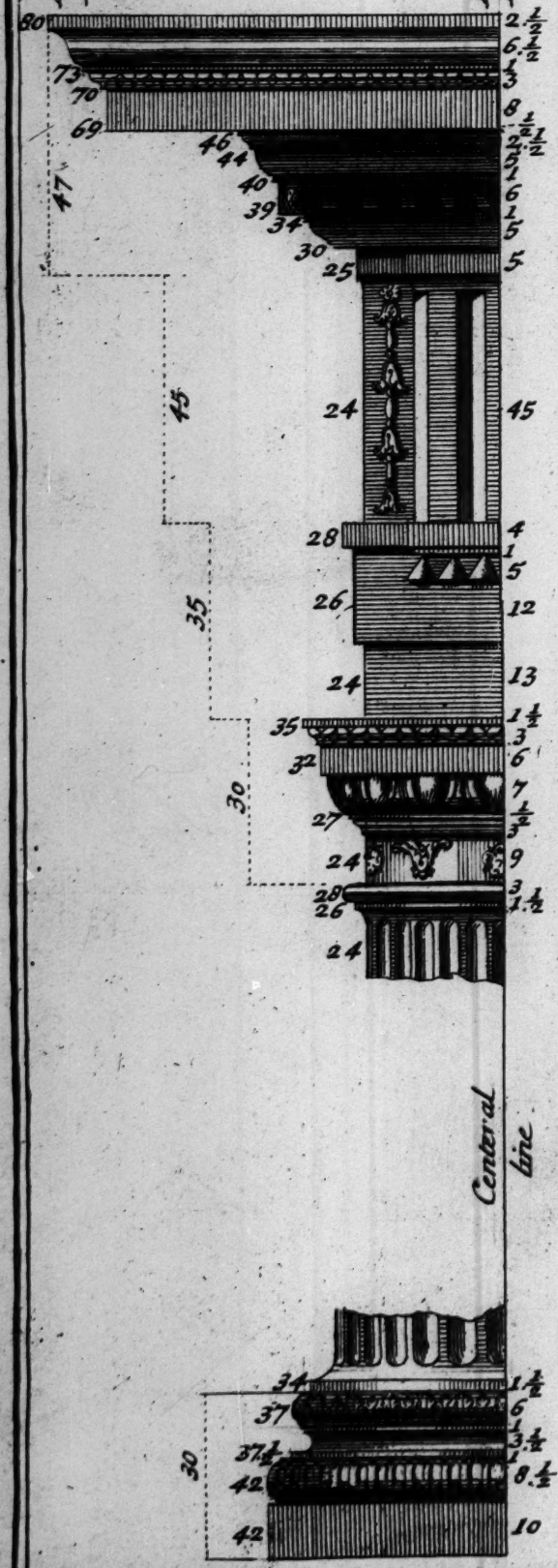
The Column nr.th it's Base & Capital 8 Diameters

The Column nr.th it's Base & Capital 8 Diameters

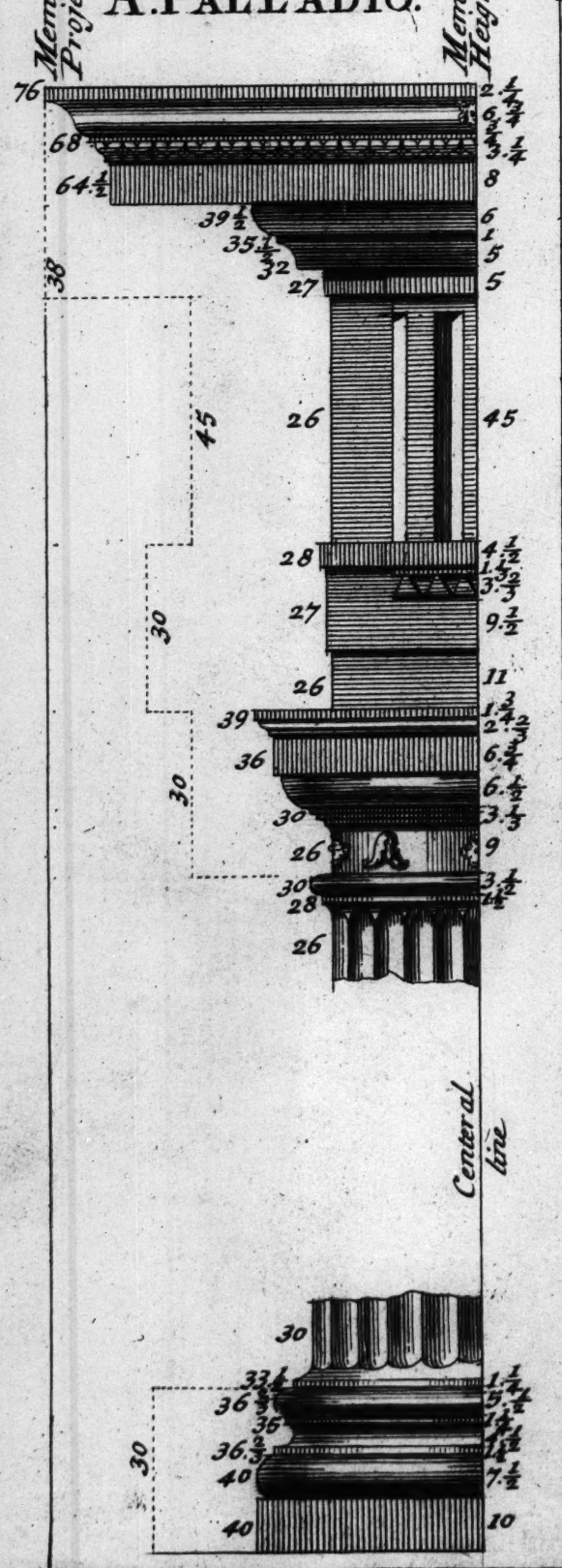
Geometrical Elevations of ye DORICK Base, Capitals, and Entablatures according to the proportions of



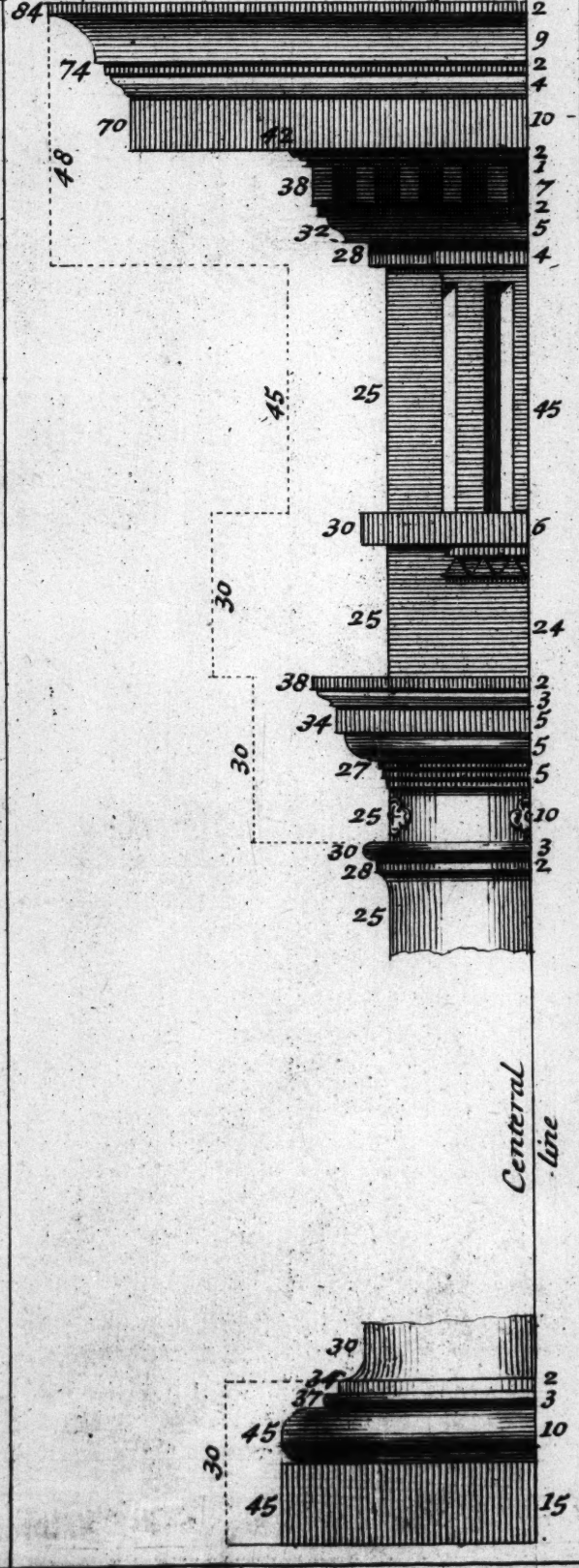
Scamozzi.



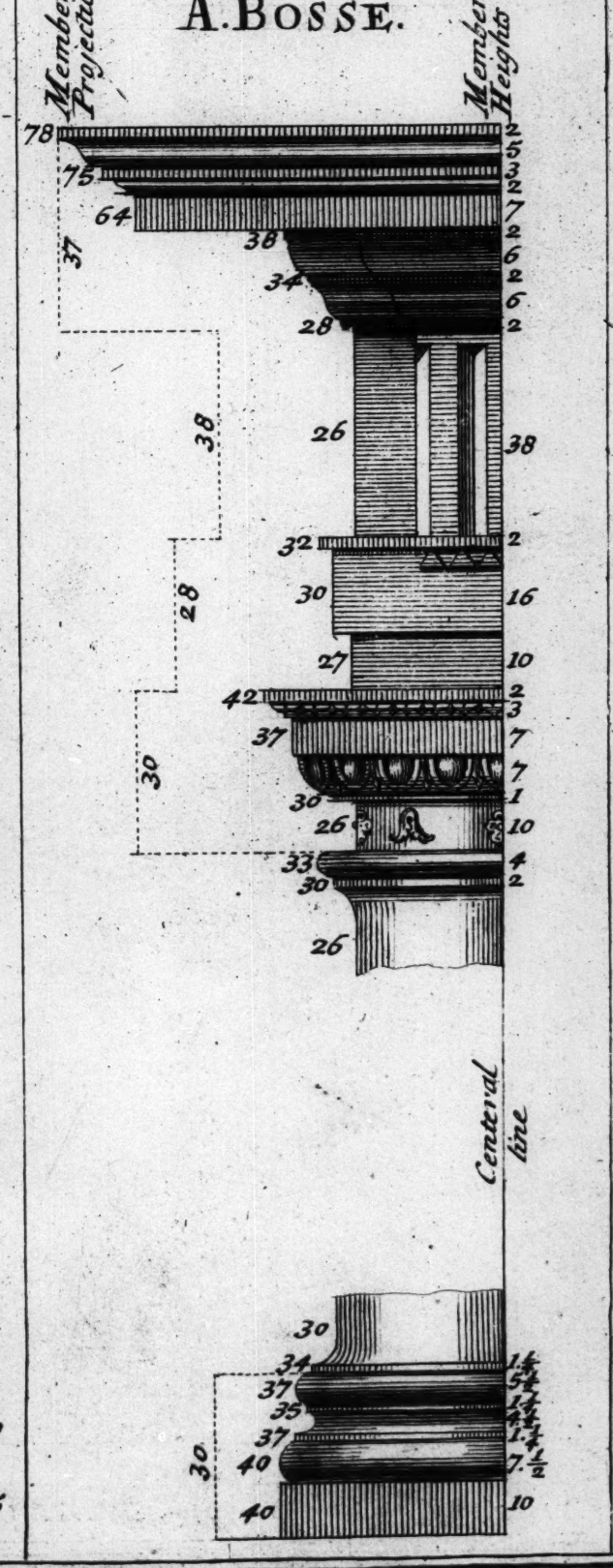
A. Palladio.

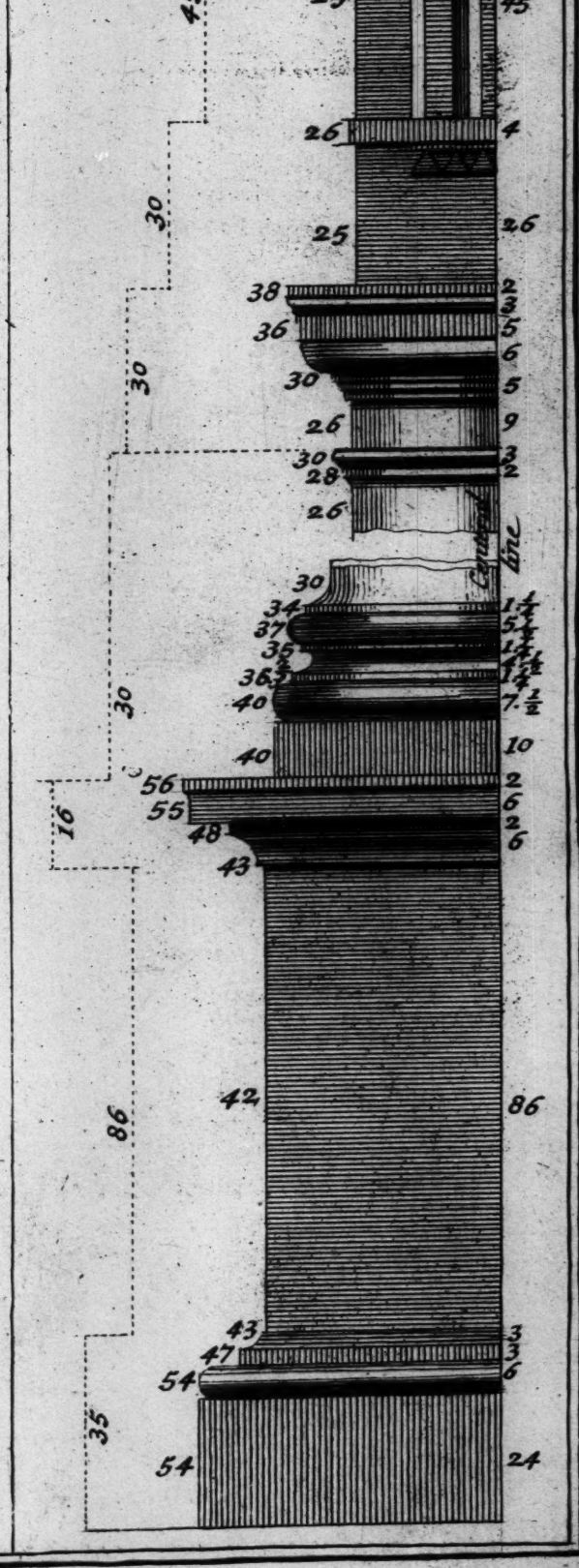


M. Angelo.

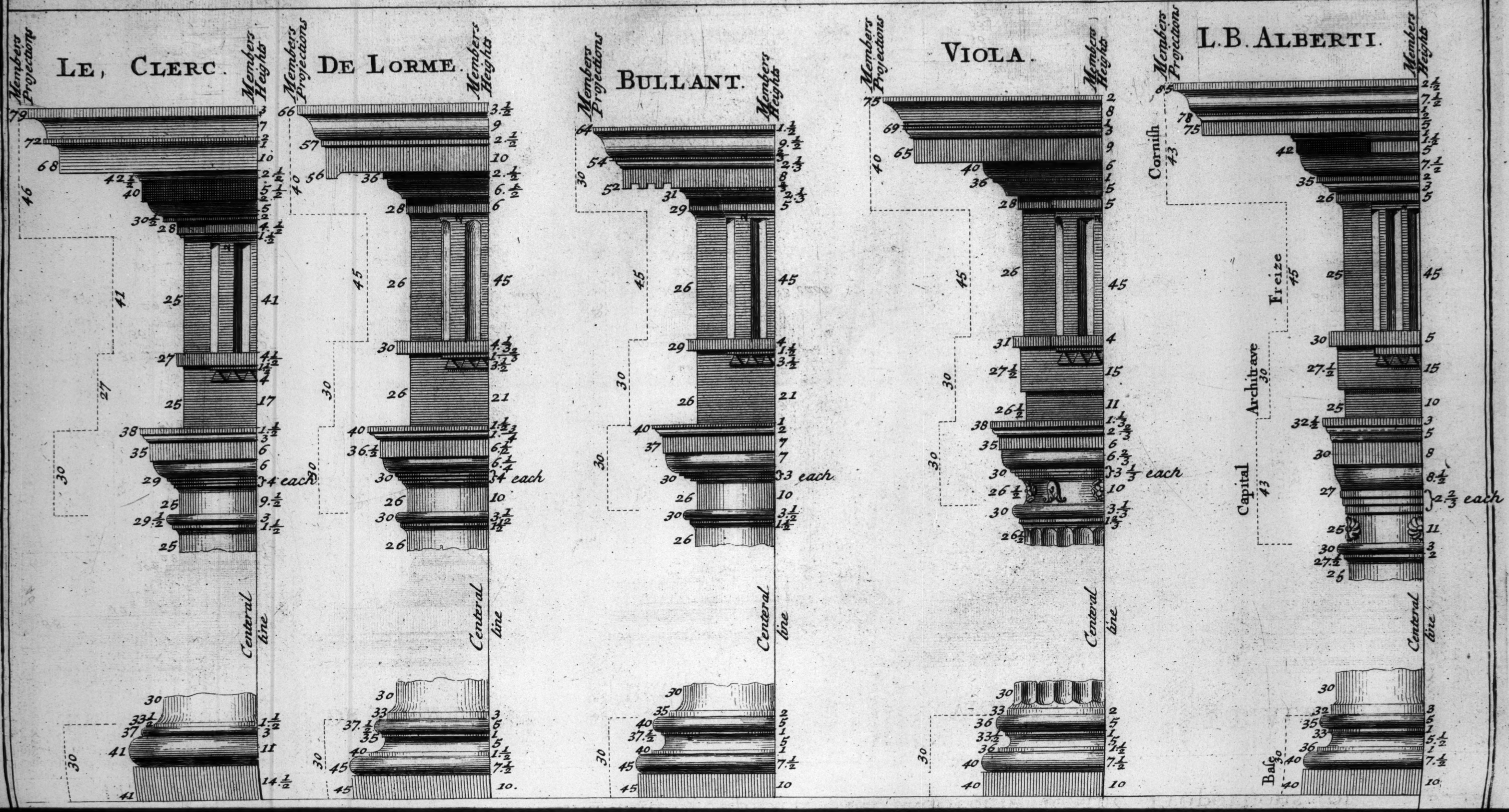


A. Bosse.

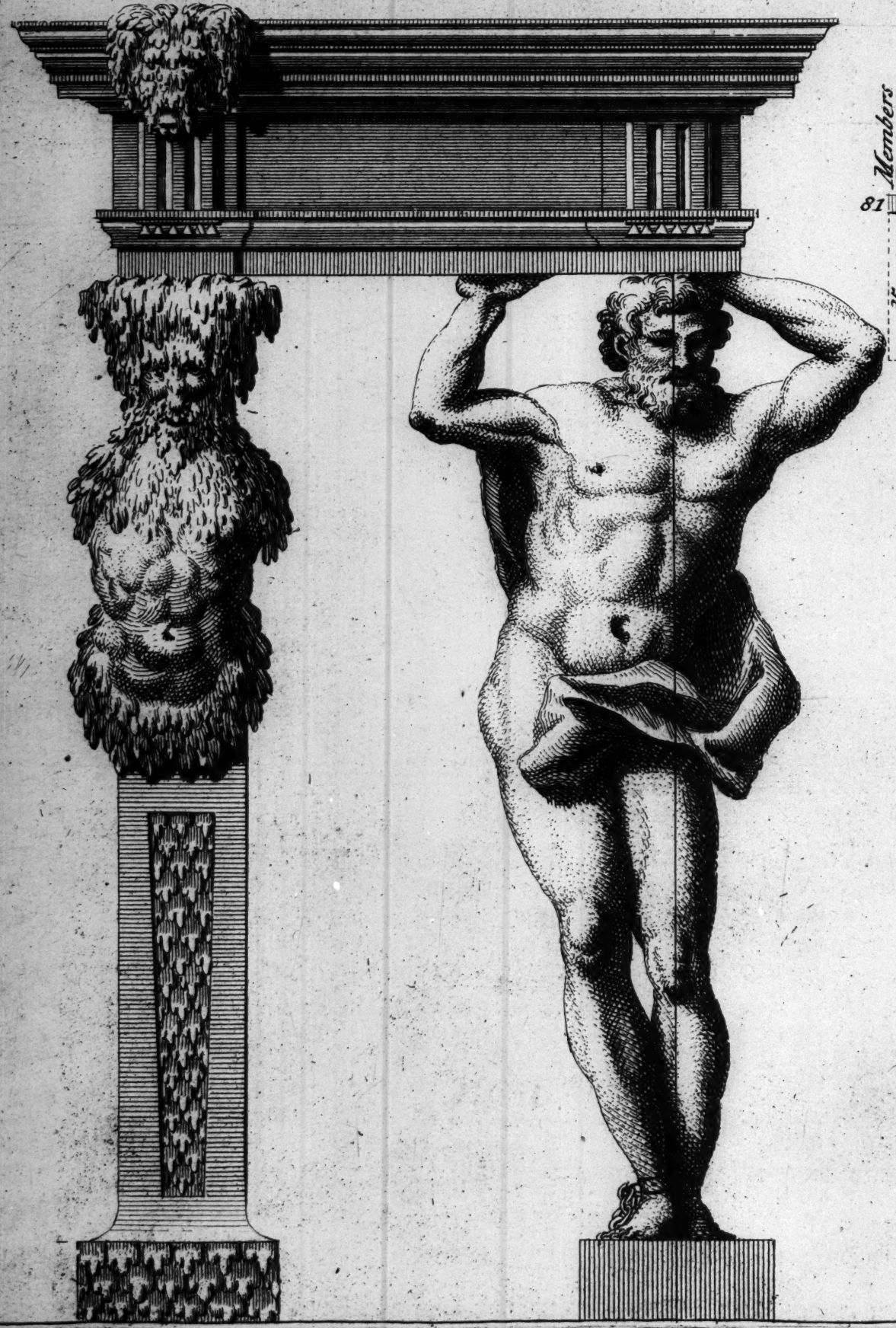




Geometrical Elevations of the *DORICK* Entablature, Capital & Base according to the Proportions, of



The *Persian* Order.



Albane near Rome

Members Projections	Members Heights
81	4
72	9
	1 3
35 67	9
37	1 3
33	5 3
30	
28	42
45	
31	4 1 1 1/2
29	14
31	1/2
26	7
38	2 3
34	1 6 1/2
29	6. 1/2
26	8
27	1 1/2
30	3 1 1/2
28	
26	
Centeral line	
30	
34	

Bath of Diocletian at Rome.

Members Projections	Members Heights
73	3
	7
66	1 4
	6 1/2
60	1 6
45	1 1/2
46	
40	7
39	1 4
33	4
30 28	
25	45
45	
29	2/3
26	15
32	2
25	10
39	2/3 1/2
35	8 1/2
30	6 1/2
29	7 1/4
30	3/4 2
25	
Centeral line	
30	

Theatre of Marcellus at Rome.

Members Projections	Members Heights
84	5. 1/4
	9. 1/4
74 1/2	1 2. 1/4
70	8. 3/4
37 1/2 68	1 1/4
37	6 1/2
33	1 1/2
30	3 5
25	
45	
24	
26	4 1/2
30	2 4
24	19. 1/2
37	2 1/2
30	3. 1/2
33	8
28	4. 1/2
	4
28	7. 1/2
26	3
24	1. 1/4
Centeral line	
3	
33	

Plate XXII

Profiles of the *IONICK* Order, According to

The Temple of Manly Fortune at ROME.

The Theatre of MARCELLUS.

The Bath of DIOCLETIAN.

VITRUVIUS.

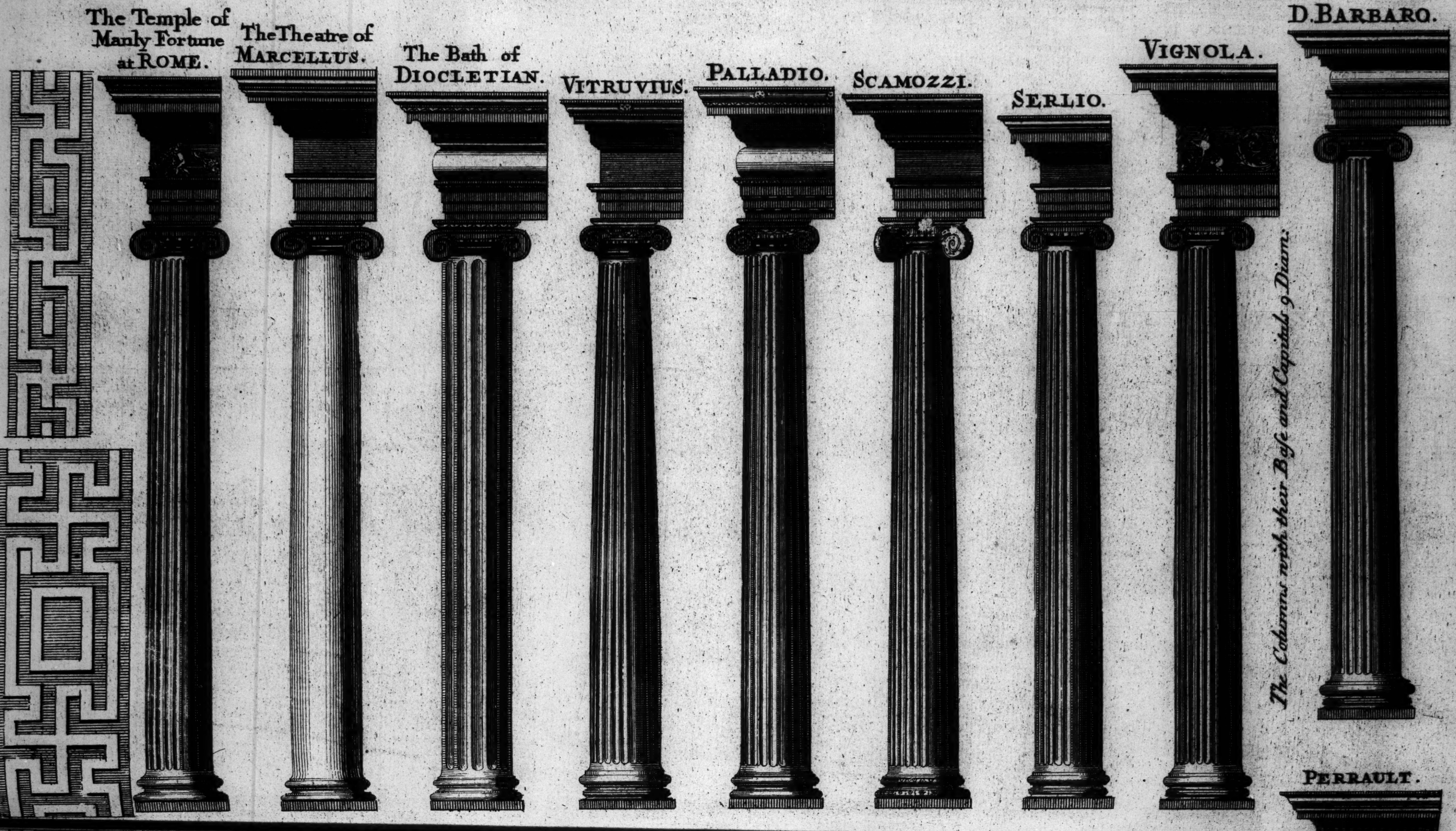
PALLADIO.

SCAMOZZI.

SERLIO.

VIGNOLA.

D. BARBARO.



The Columns with their Base and Capitals 9 Diam:

PERRAULT.

CATANEO.

L.B. ALBERTI.

VIGLA.

P. DE LORME.

I. BULLANT.

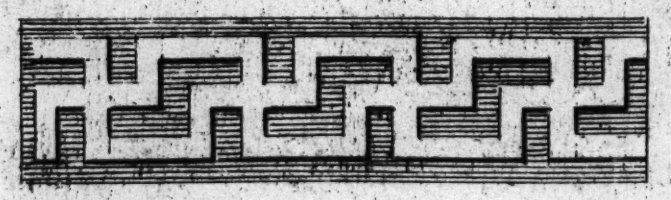
A. BOSSE.

LE CLERC.

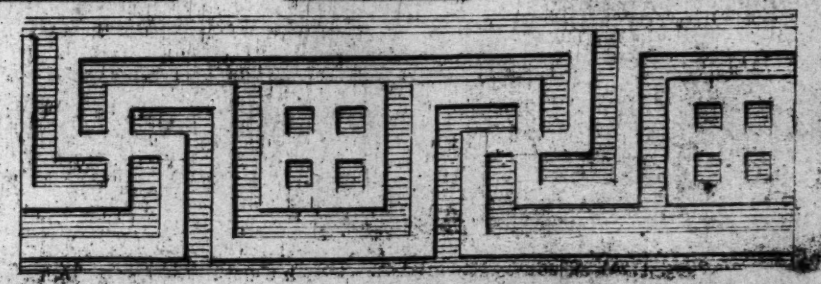
M. ANGELO.

The Cottumns with their Base and Capitals 9 Diameters

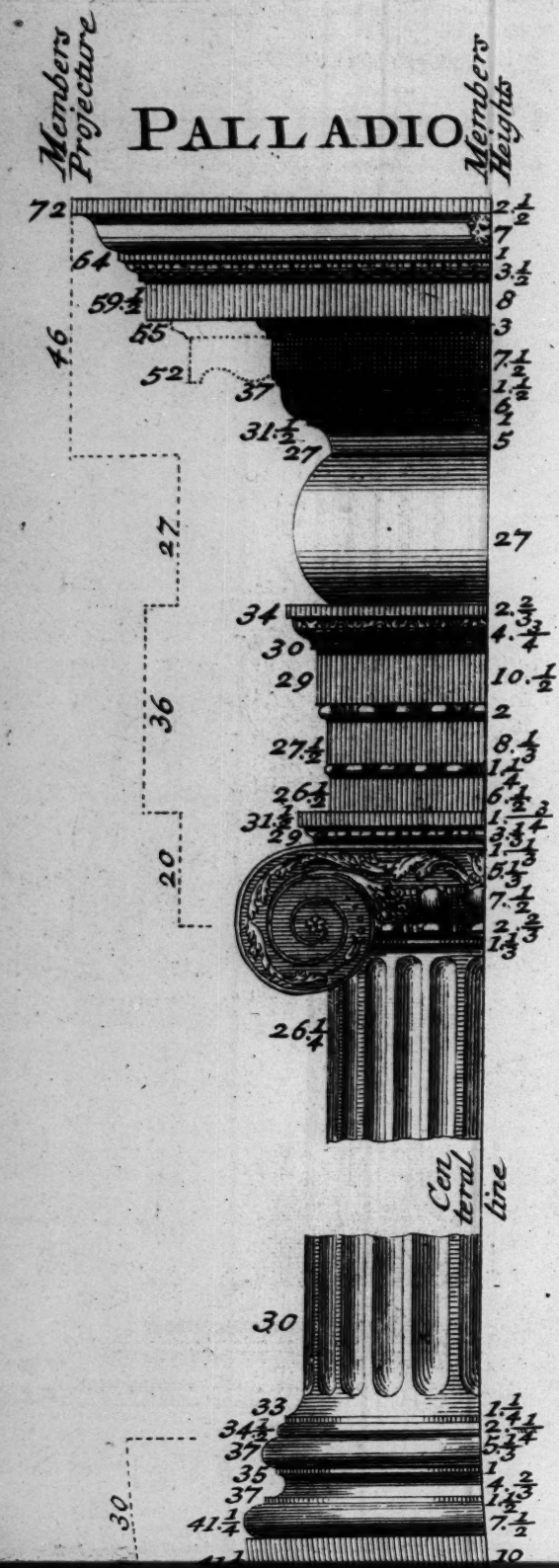
The Fret by the

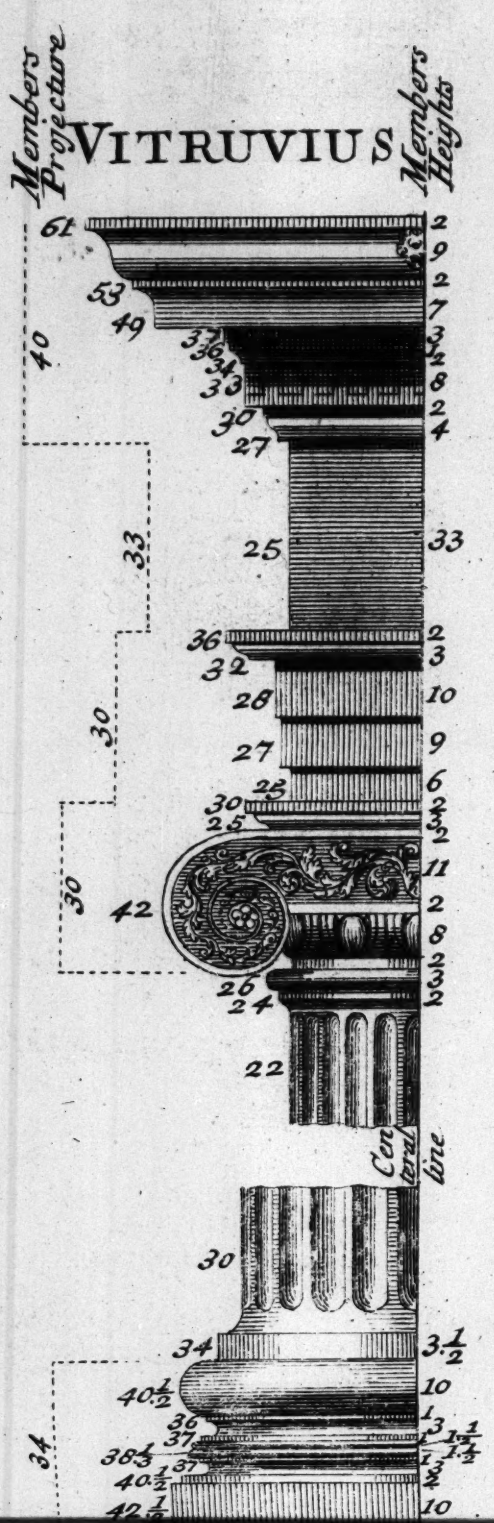


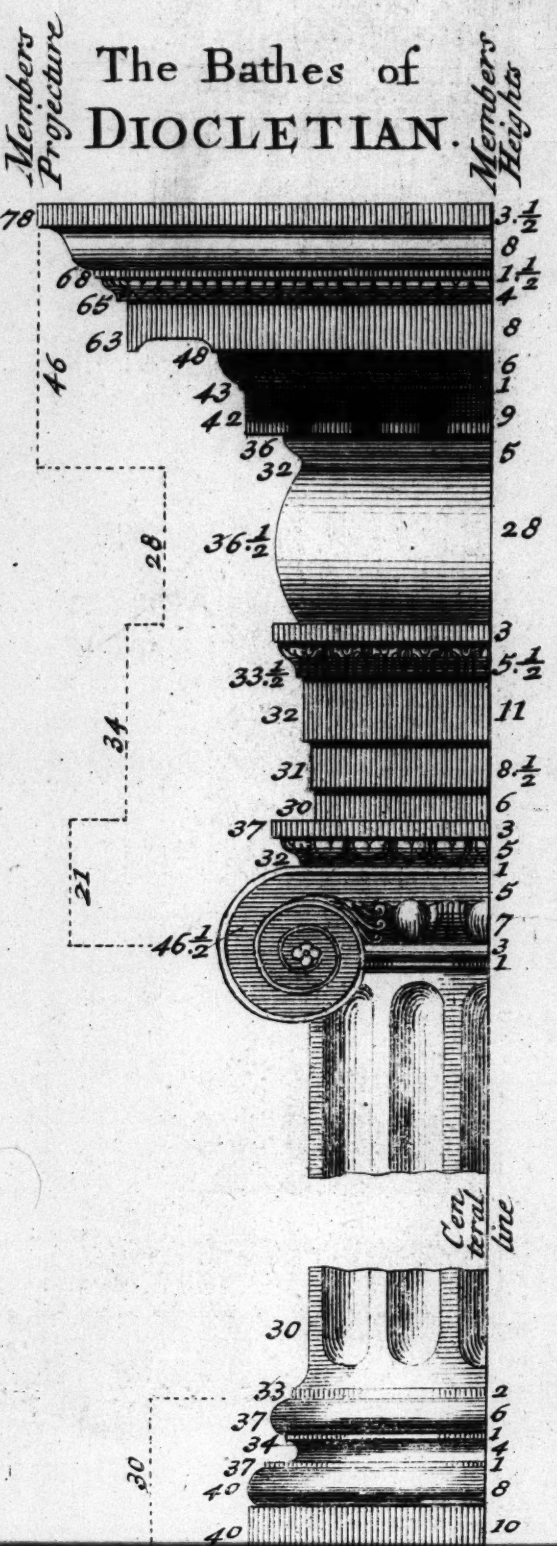
Work Used Antients.

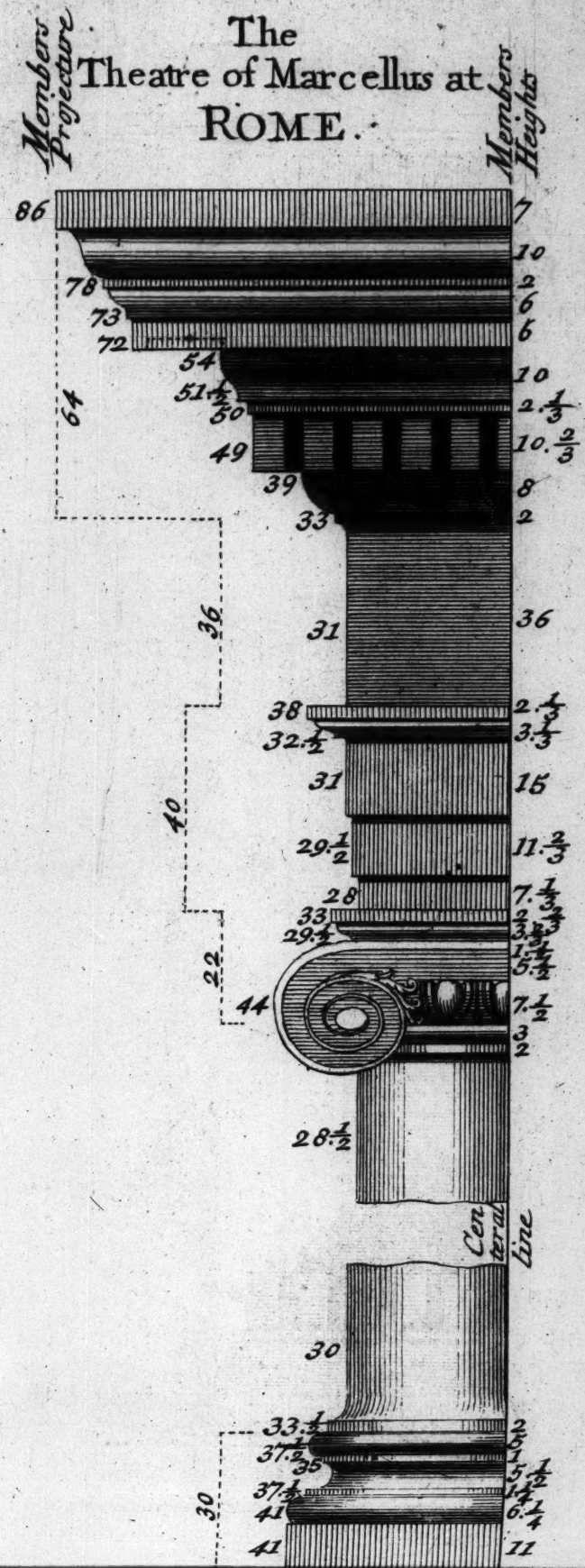


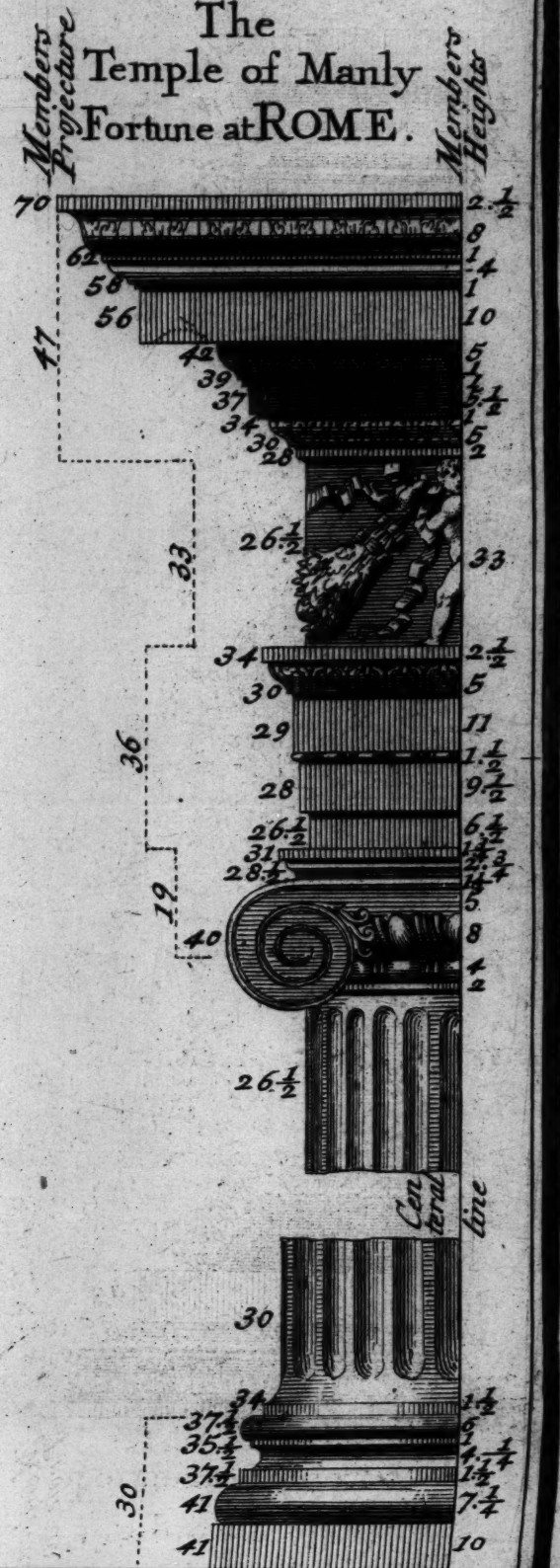
Geometrical Elevations of ye *IONICK* Base, Capitals, and Entablatures according to the Proportions of





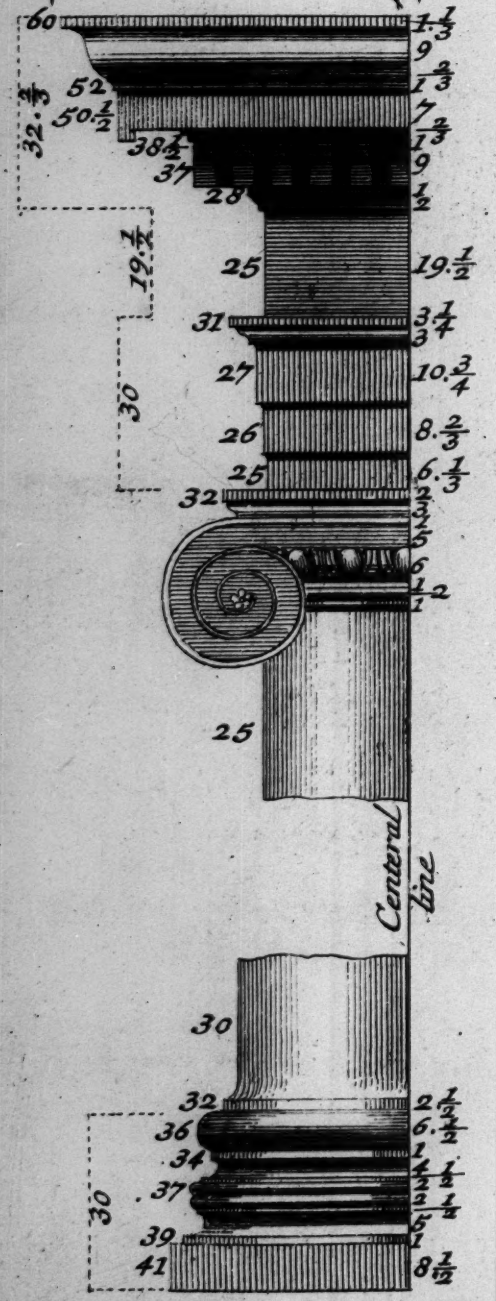






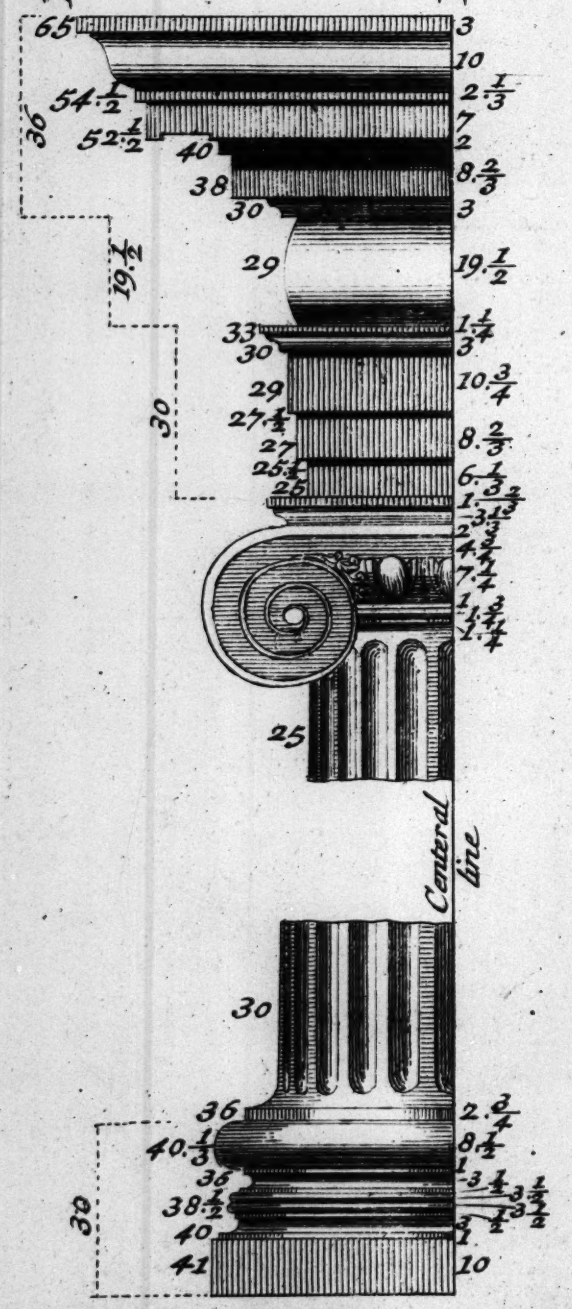
CATANEO

Members Projecture — Members Heights



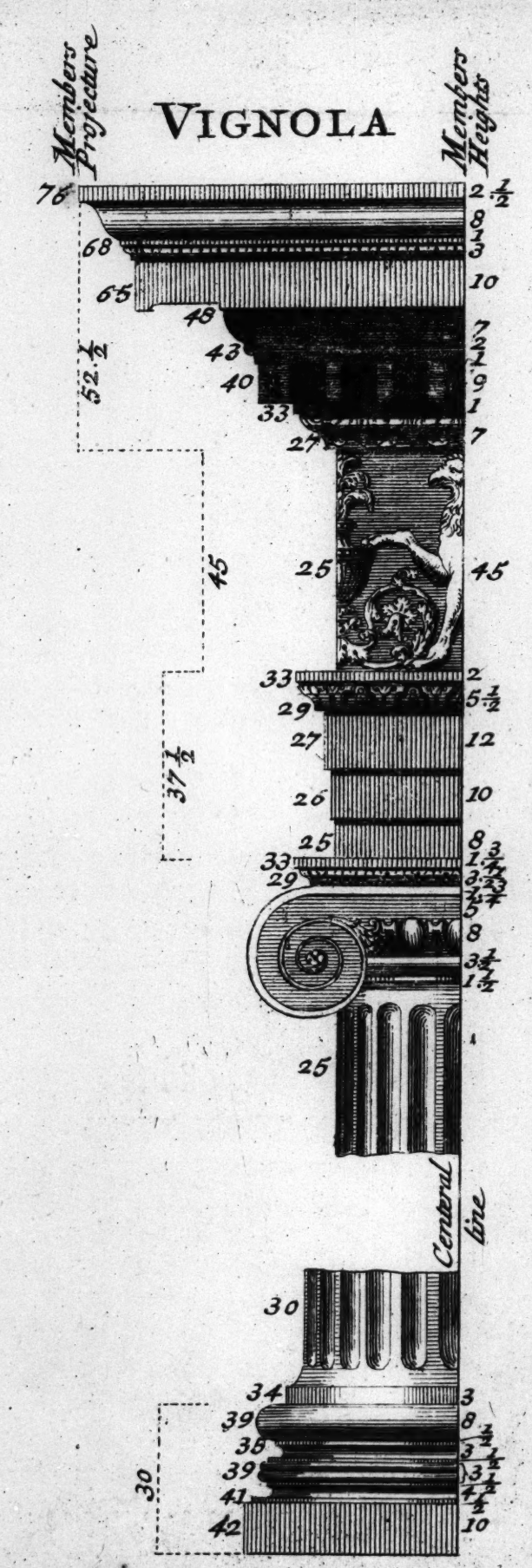
D. BARBARO

Members Projecture — Members Heights



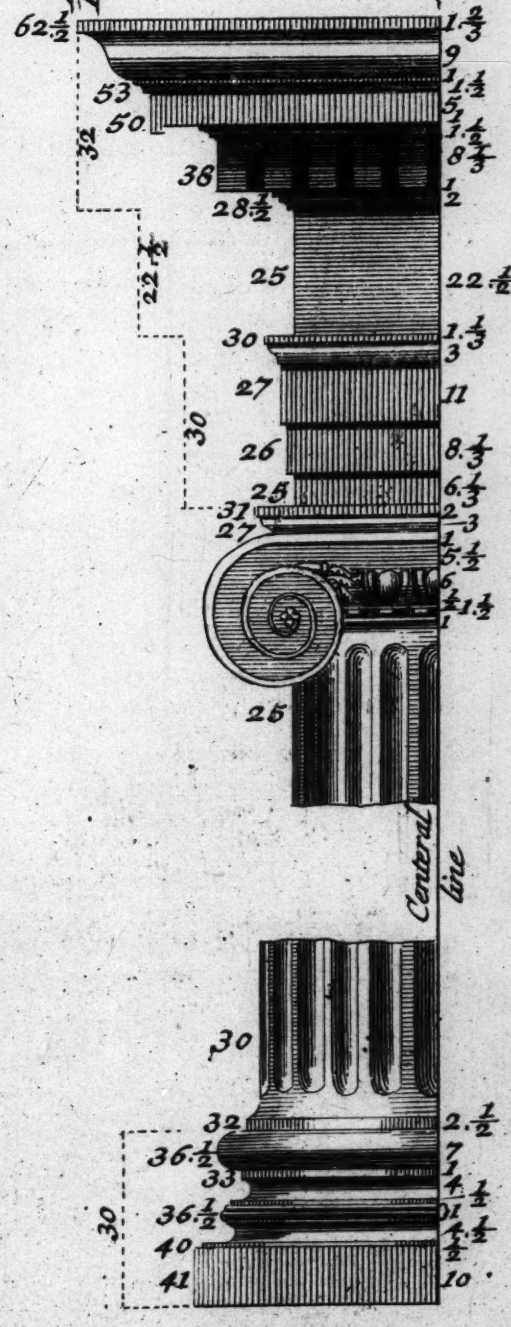
VIGNOLA

Members Projecture — Members Heights



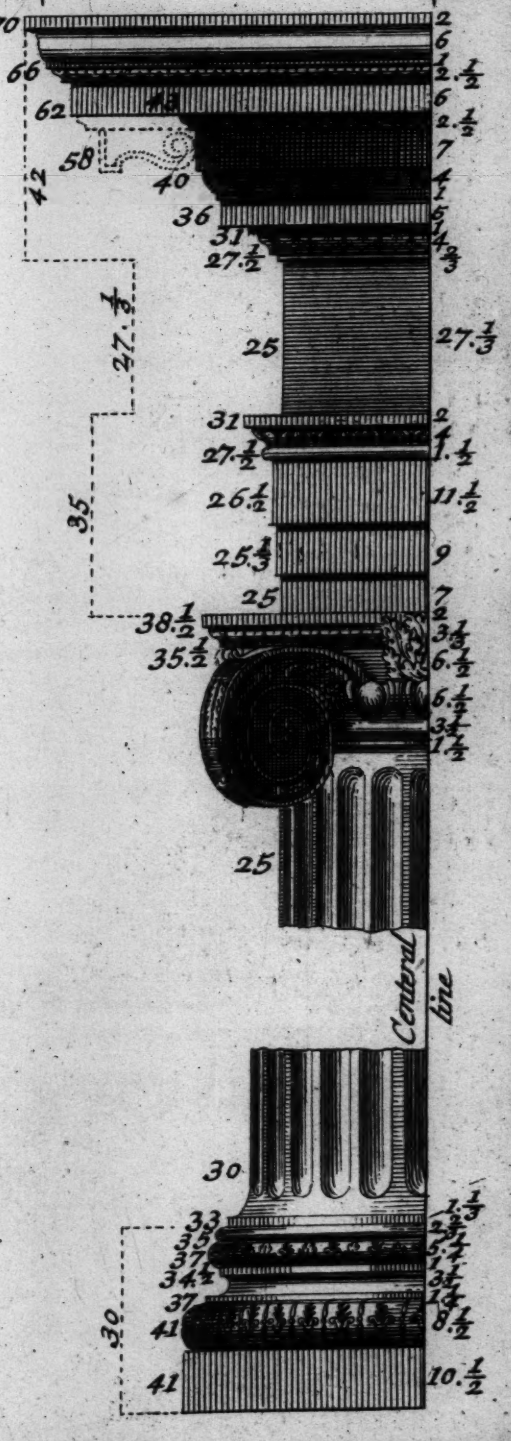
SERLIO

Members Projecture — Members Heights

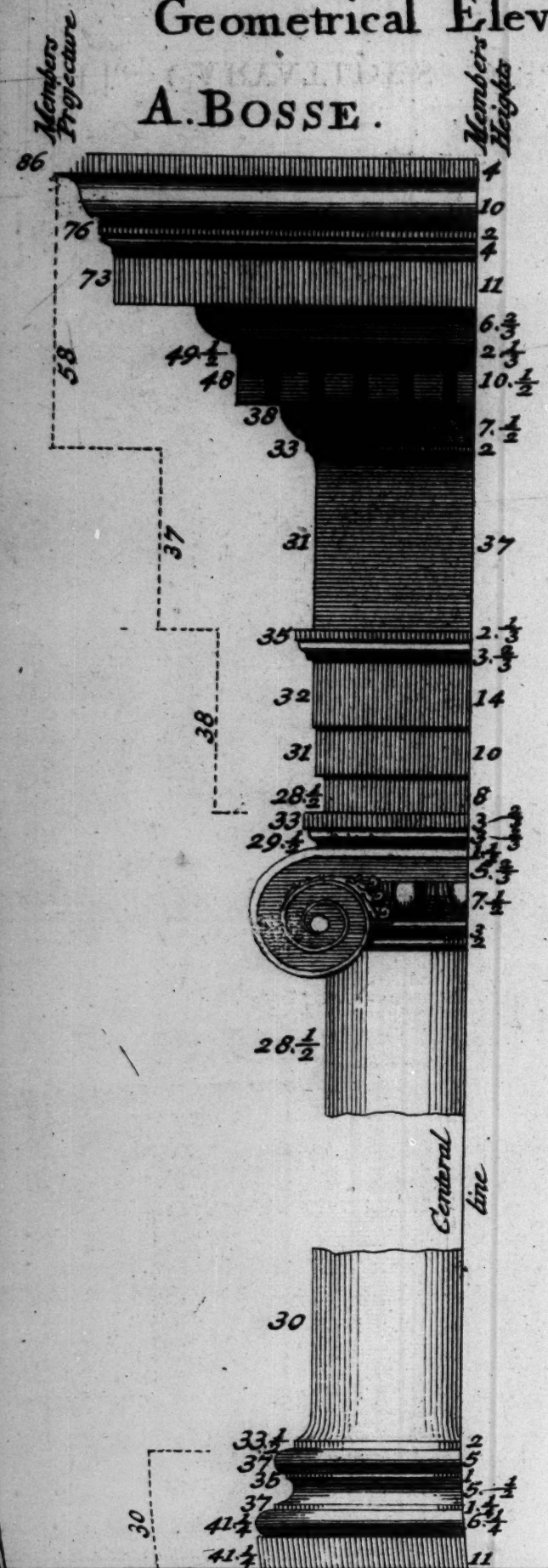


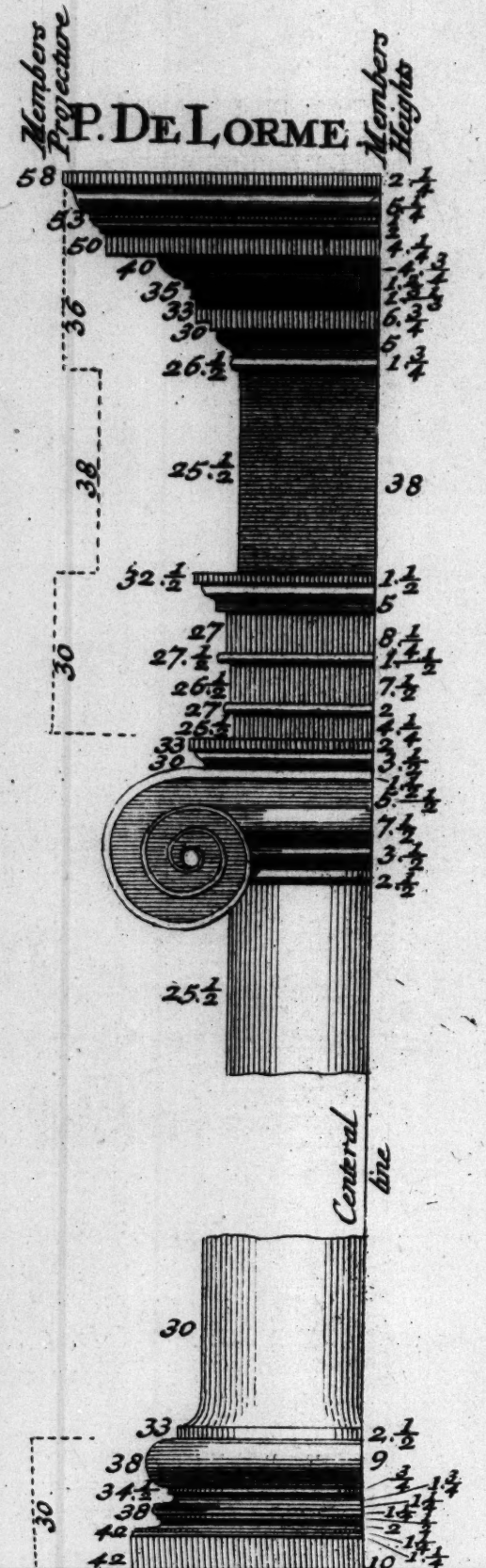
SCAMOZZI

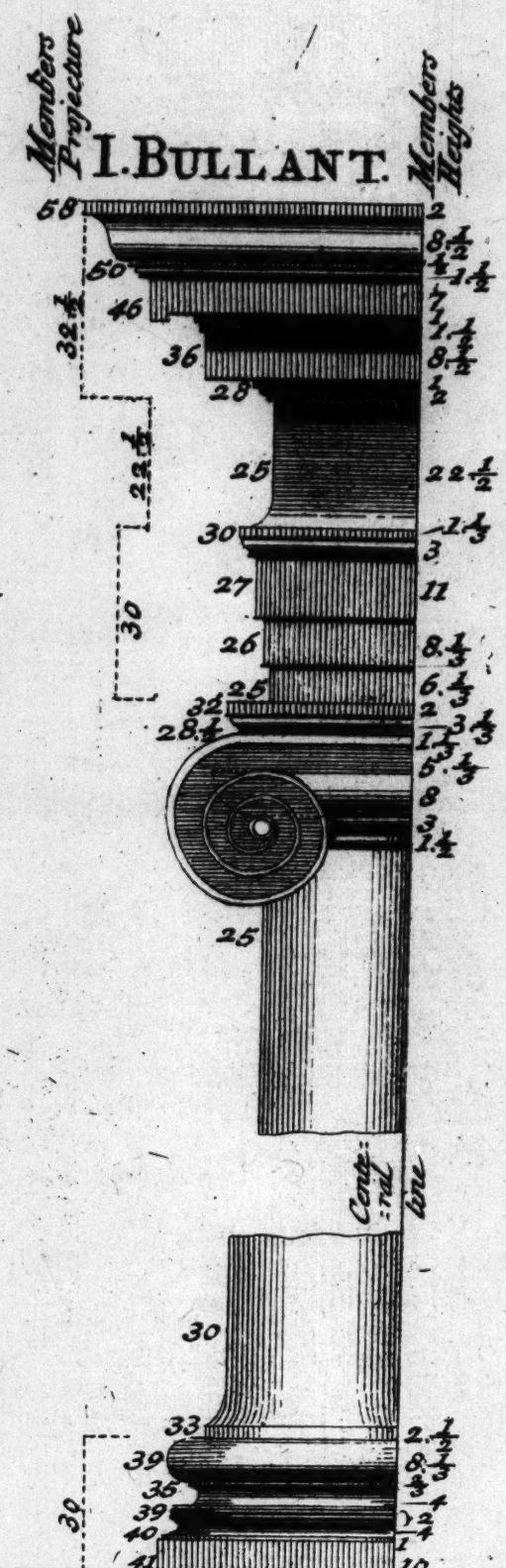
Members Projecture — Members Heights

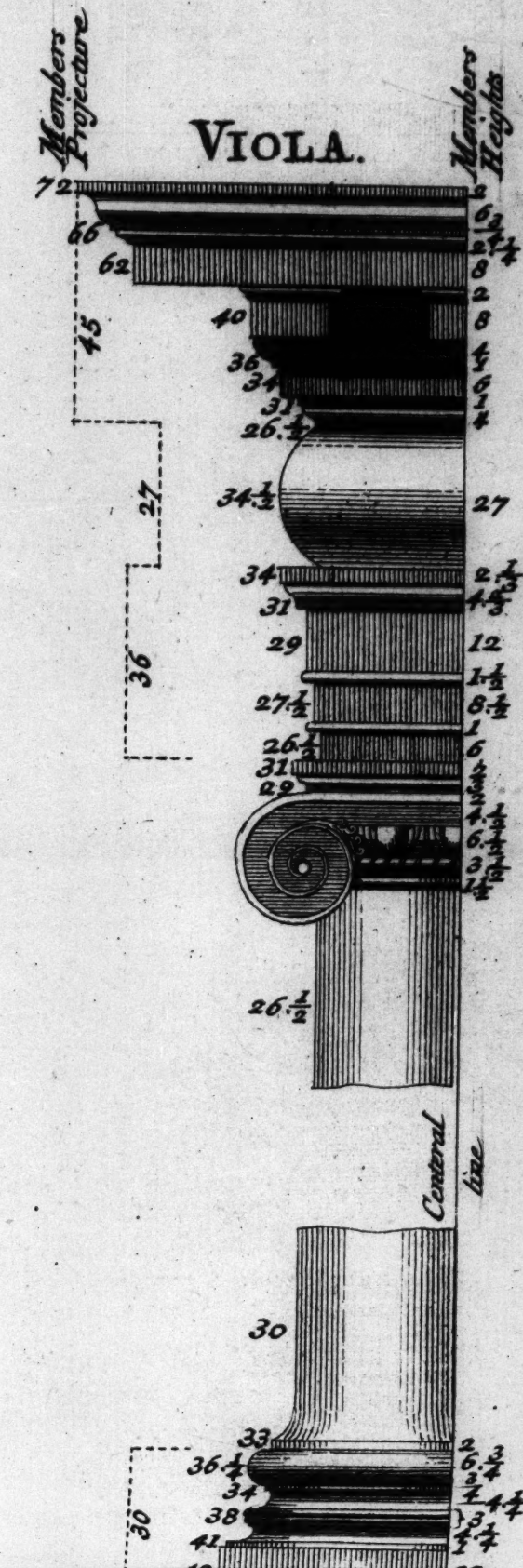


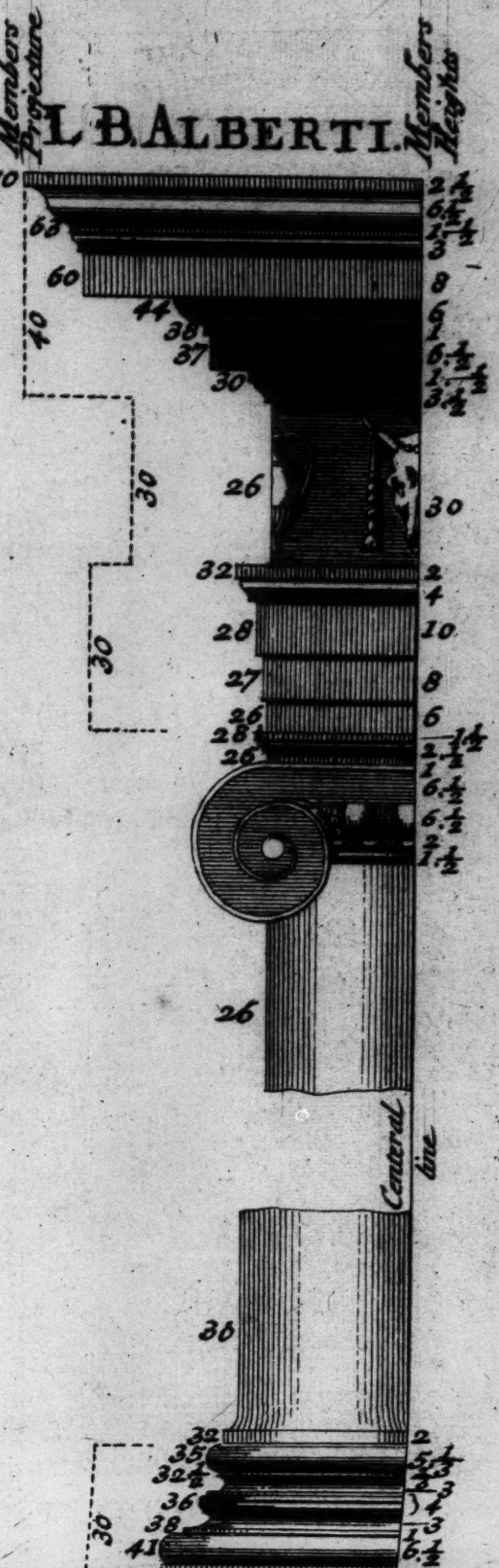
Geometrical Elevations of the *IONICK* Base, Capitals, and Entablatures according to the Proportions of





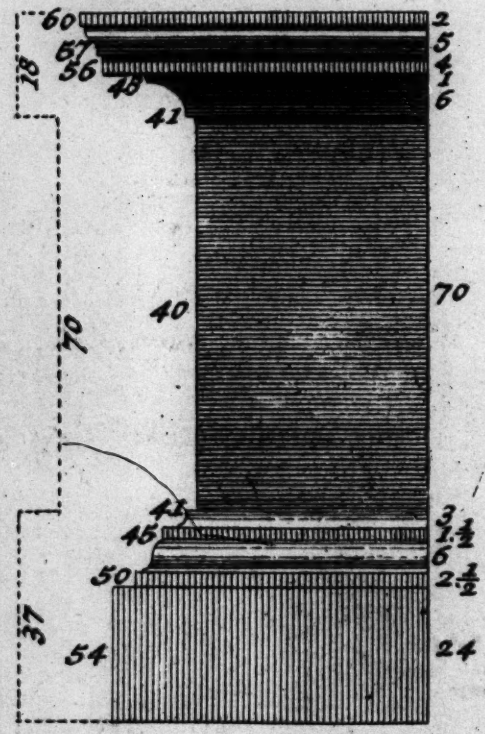




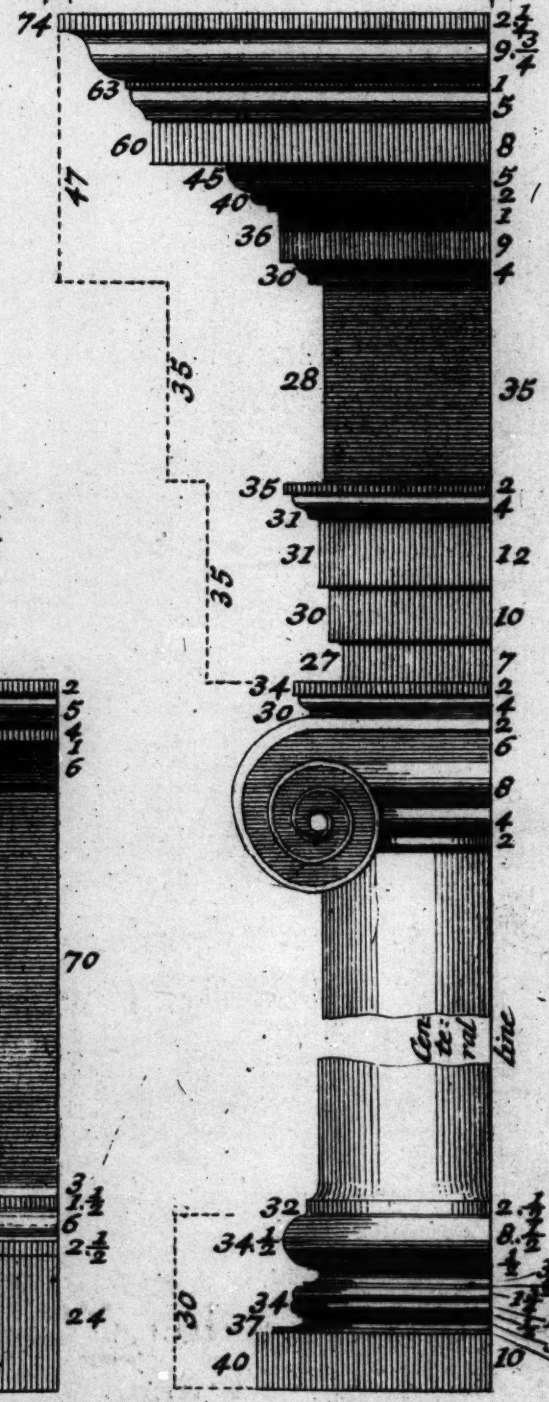


The CARYATIDES Order.

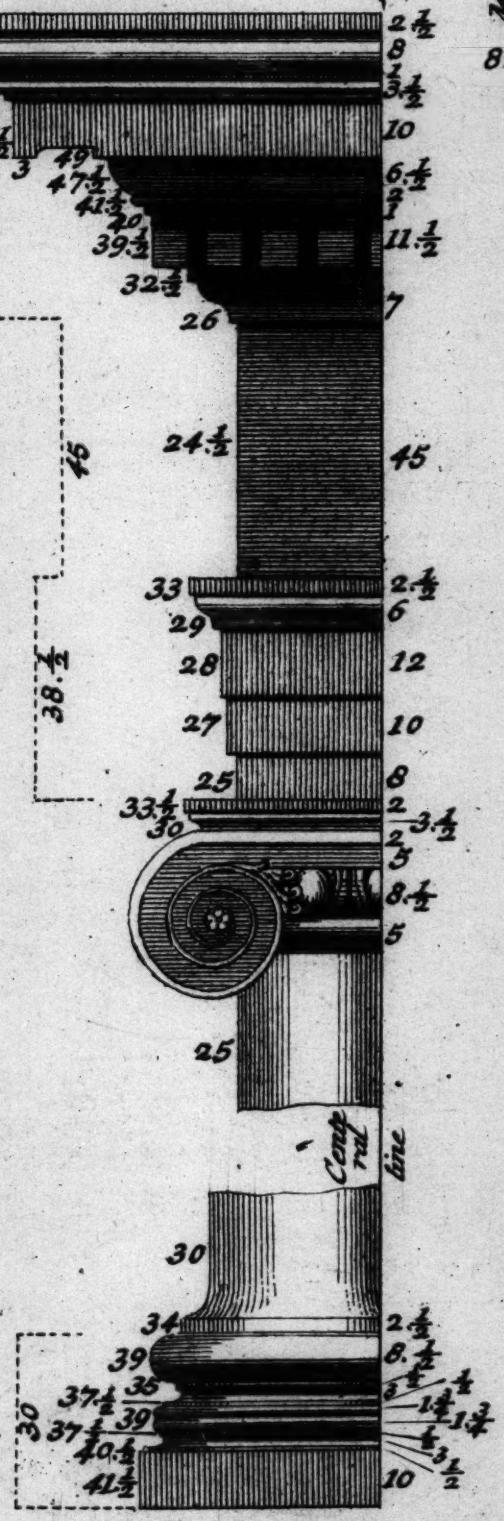
The IONICK Pedestall according to PERRAULT.



PERRAULT.



M. ANGELO.



LE CLERC.

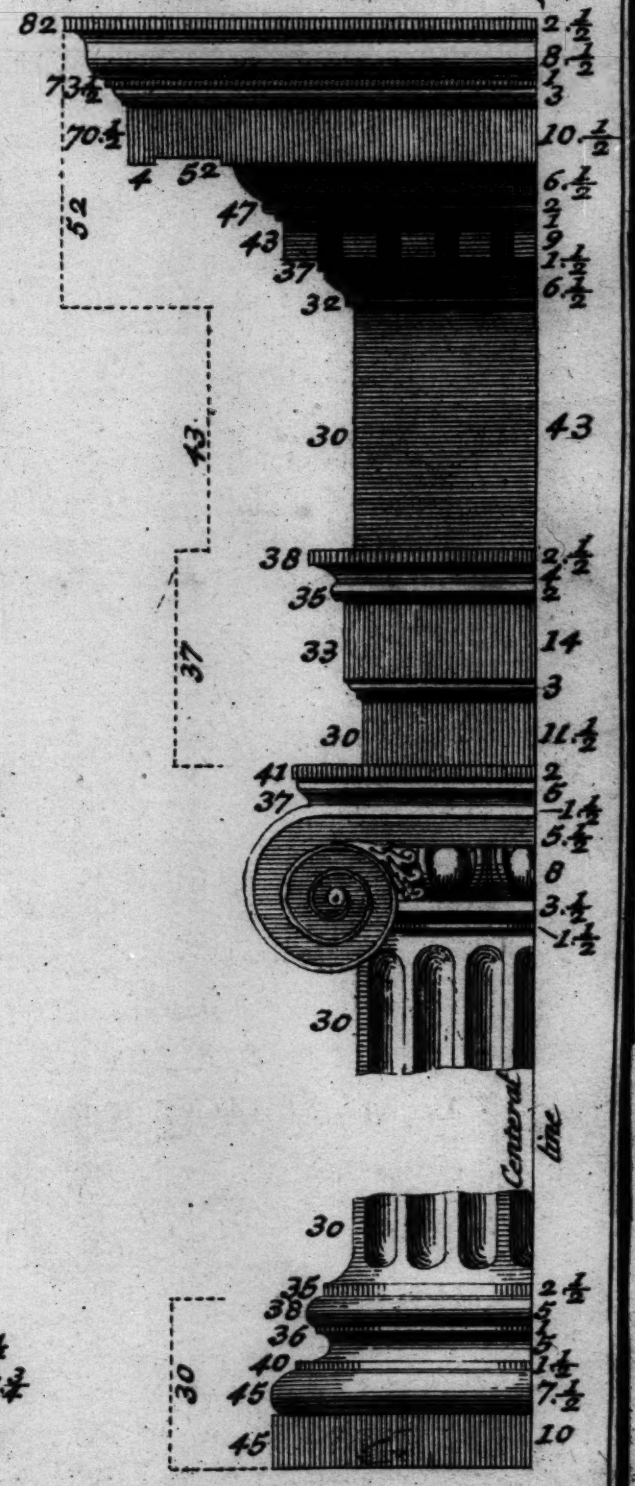
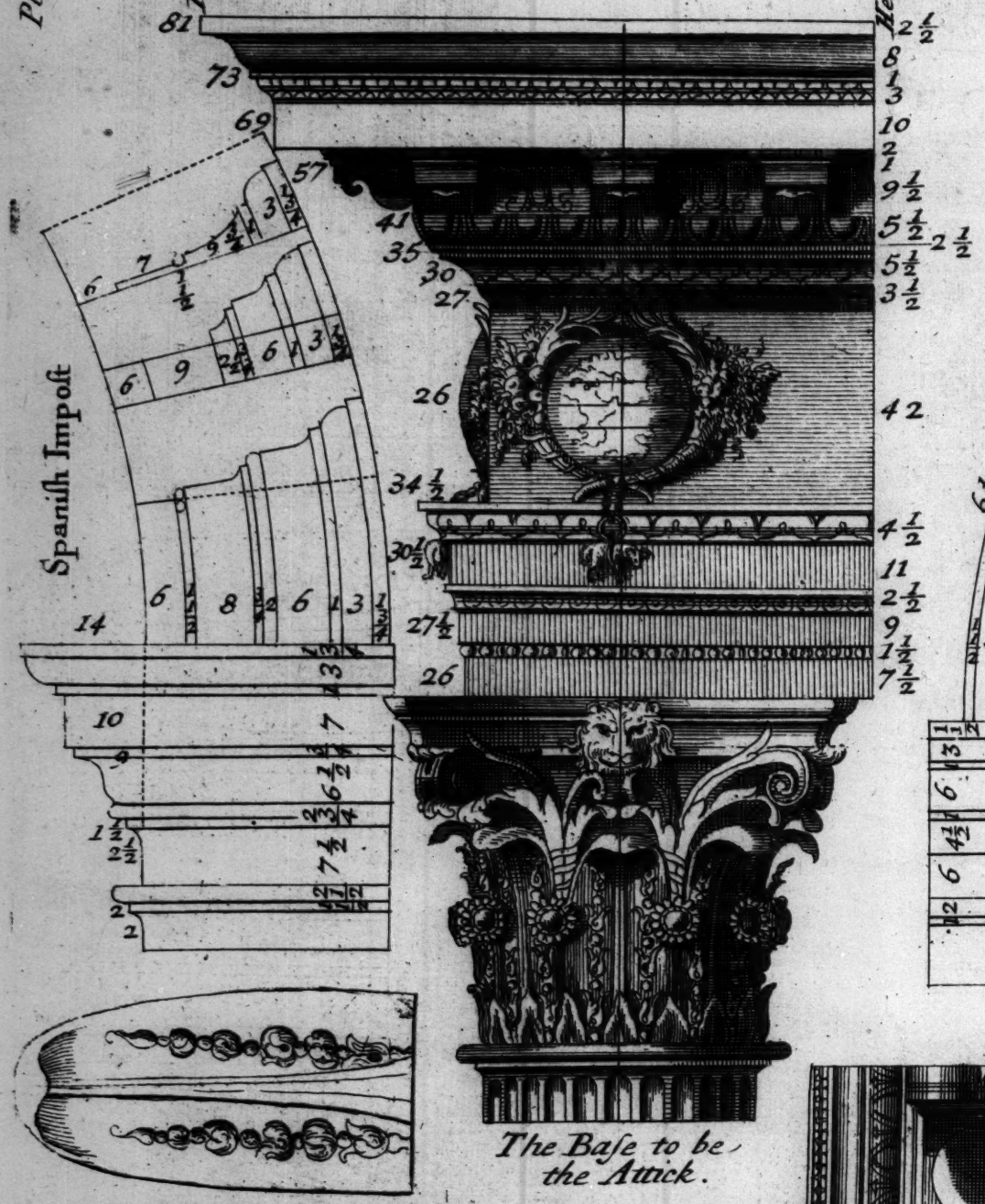


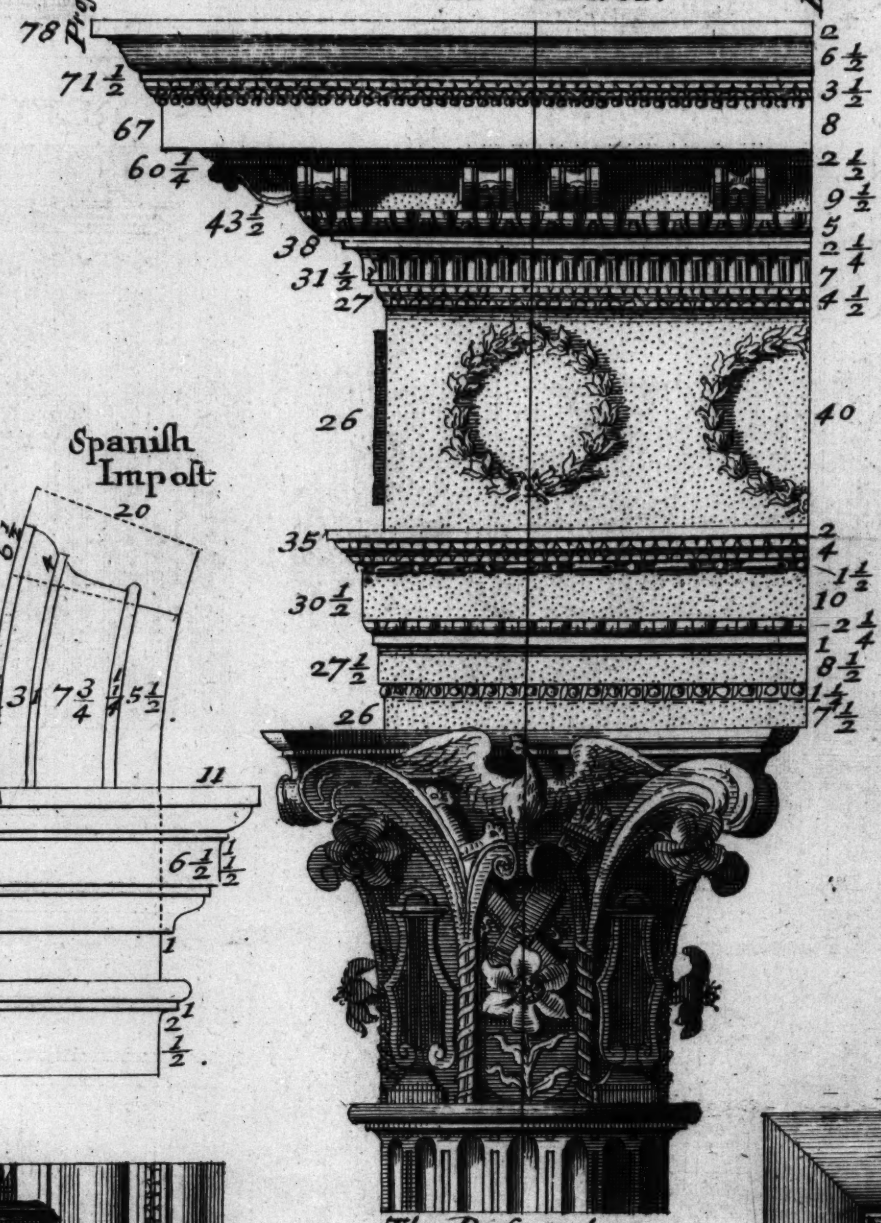
Plate. 26.

LE CLERCS Elevations of the

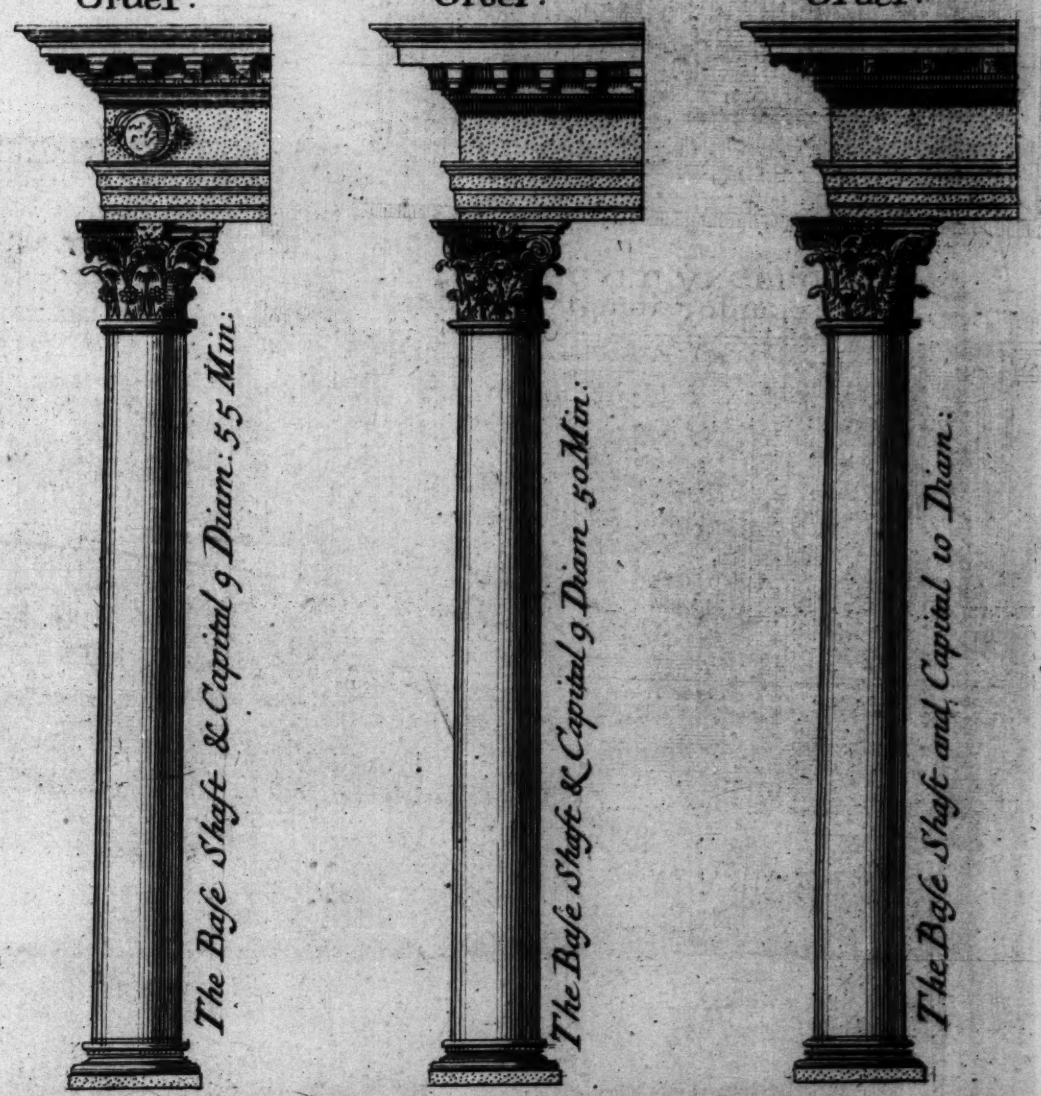
SPANISH Order.

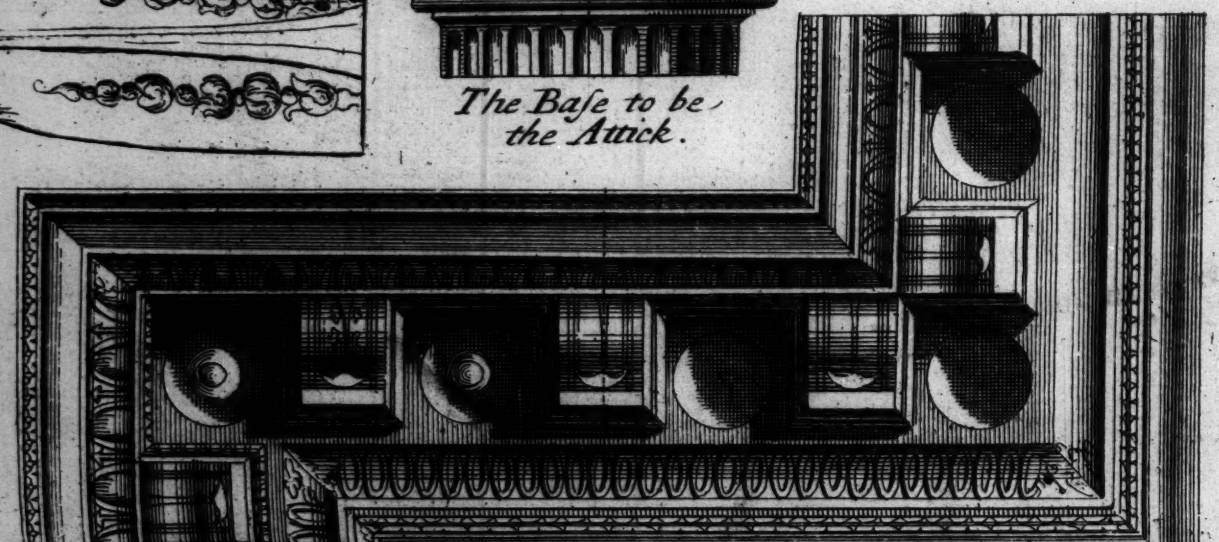


FRENCH Order.



LE CLERCS Profiles of the





Roman Key Stones by Le Clerc.

Roman Key Stones
by Le Clerc.

Spanish Sopheta *by* LE CLERC.

40 ½
1. m. 25.

Jonick Key Stones
by LE CLERC.

26
30
25

4½ 16
16

Corinthian Key Stones *by*
LE CLERC.

The Compolita Sopheta *by*
PERRAULT.

The Corinthian Sopheta *by*
PERRAULT.

An Ancient Ornament
used instead of Baluſtrades.

The Jonick Sopheta *by*
LE CLERC.

The Dorick Sopheta *by*
LE CLERC.

The Corinthian Sopheta
by LE CLERC.

Roman Sopheta *by*
LE CLERC.

Baluſtrades

Composita *Corinthian.* *Jonick.* *Dorick.* *Dorick.* *Tuscan.*

Geometrical Elevations of the *CORINTHIAN* Base, Capitals and Entablatures according to y Proportions of.

The Sopheta of the Cornish at the Bath of DIOCLETIAN.

The Sopheta of the Cornish at the Temple of JERUSALEM.

PALLADIO.

The Temple of JERUSALEM.

The Bath of Diocletian at ROME.

The Frontispiece of Neron at ROME.

The Portico of the ROTUNDA.

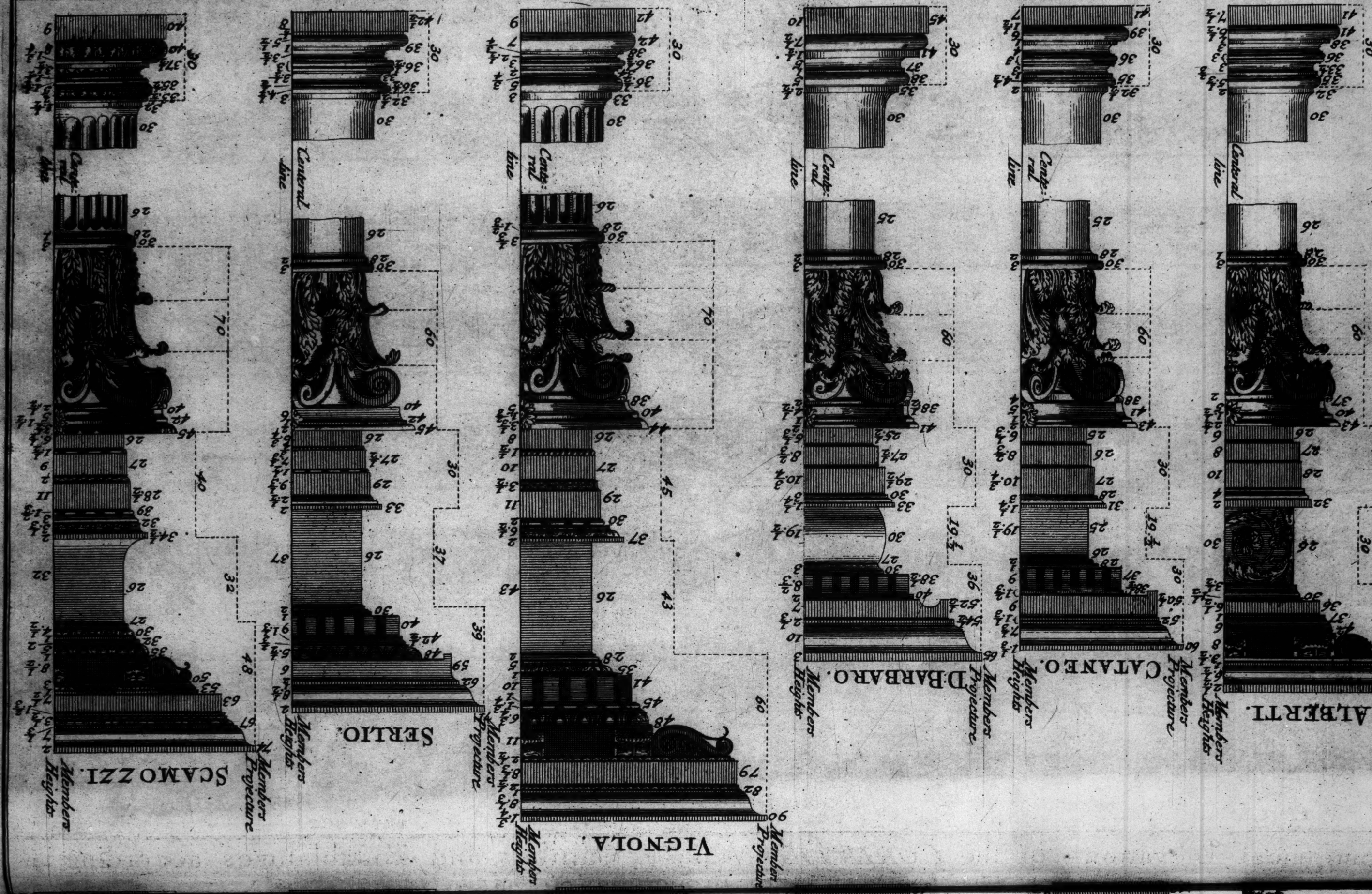
Members Proje.c

Members Heights

MP

MH

Centeral line


Scamozzi.
Serlio.
Vignola.
D. Barbaro.
Catteneo.
Alberti.
Center line
Members Heights
Members Projecture

Geometrical Elevations of the *CORINTHIAN* Base, Capitals, and Entablatures according to the Proportions of

A. BOSSE. LE CLERC. DE LORME. BULLANT. VIOLA.

The Rose of y^e^ Abacus of the Capitals in y^e^ Pantheon in the Temple of Faustina, of Jupiter Fulminans, of Mars the Revenger, in the Baths of Diocletian, & the Market of Nerva.

The Rose of the y^e^ Temple wherein the likeness of y^e^ Abacus of Capitals in of Vesta is placed an Ear of Wheat. Instead of a Fishes tail, as above.

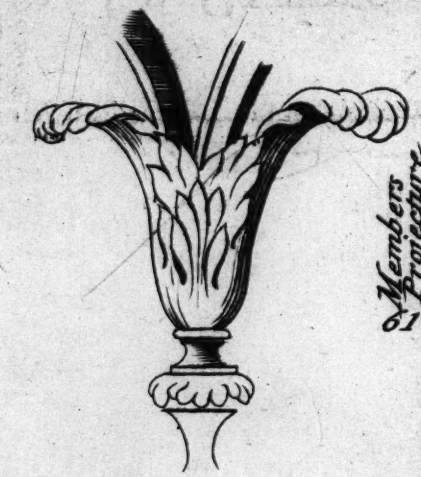
The Rose of the Capitals Columns Vaccino with Leaves the Abacus of the of the three of Campo - which is Cut of Acanthus with a Pomgranate hanging down in the middle.

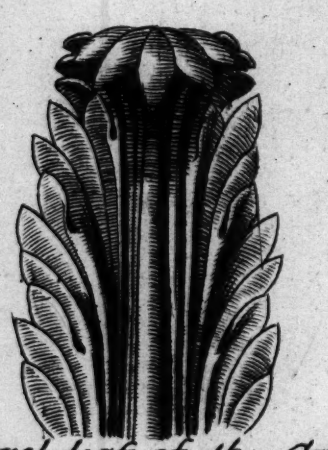
The y^e^ Abacus in the Flower of the Capitals Basilic of Anto ninus.

Mp. Mbrs Projecture Mbrs Heights

Central line

The Volute or Helix.



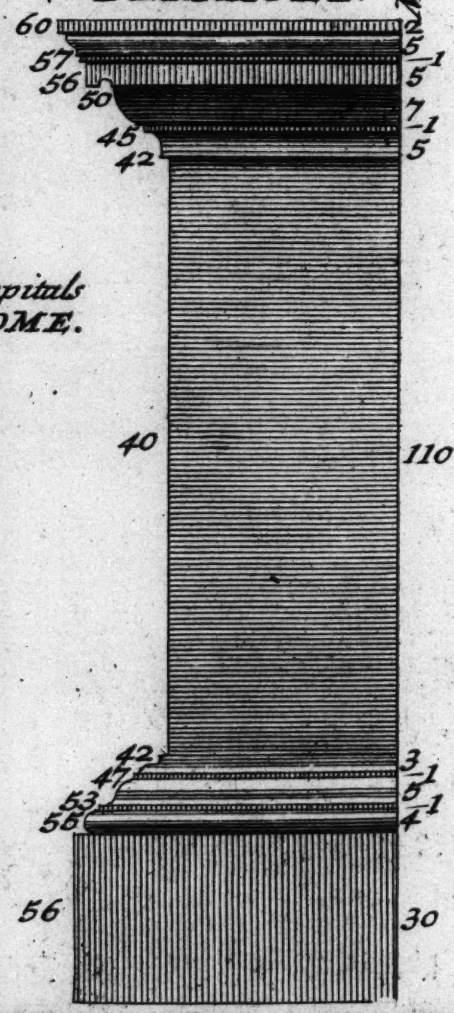


A Laurel leaf of the Capitals in the Temple of Vesta at ROME.

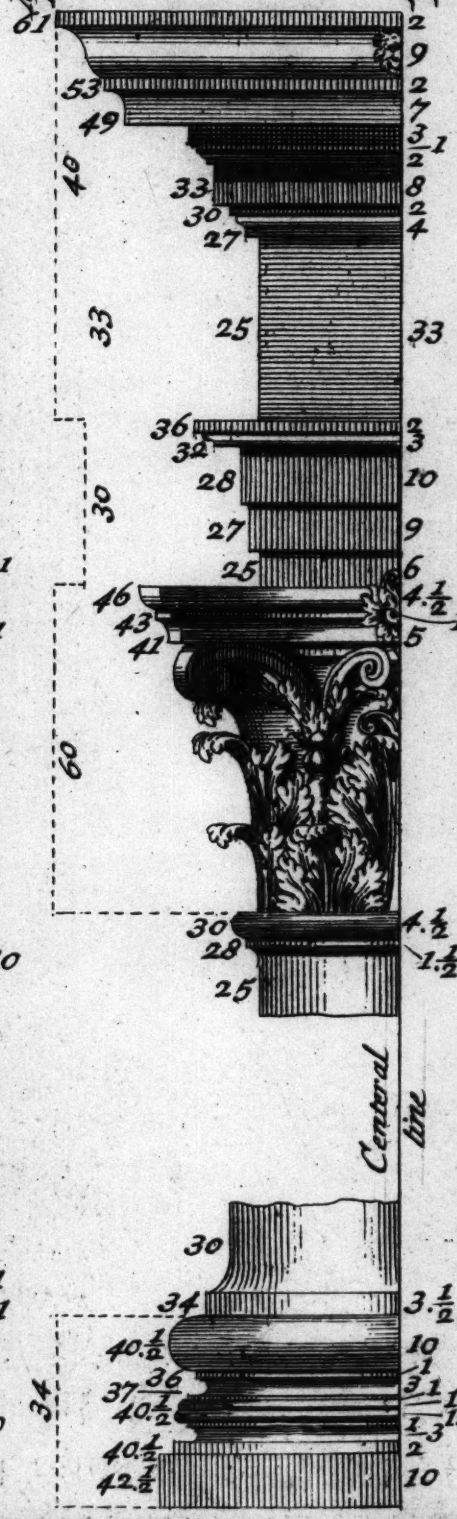
Acanthus leaf.

Olive leaf.

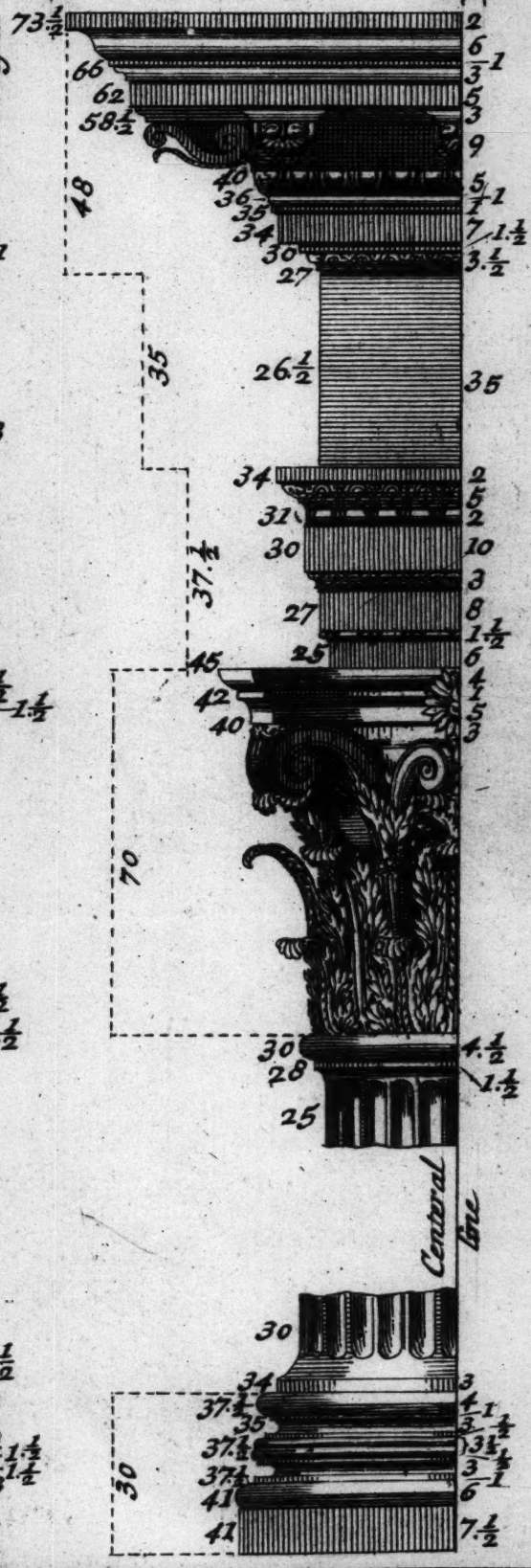
The Corinthian Pedestal according to PERRAULT.



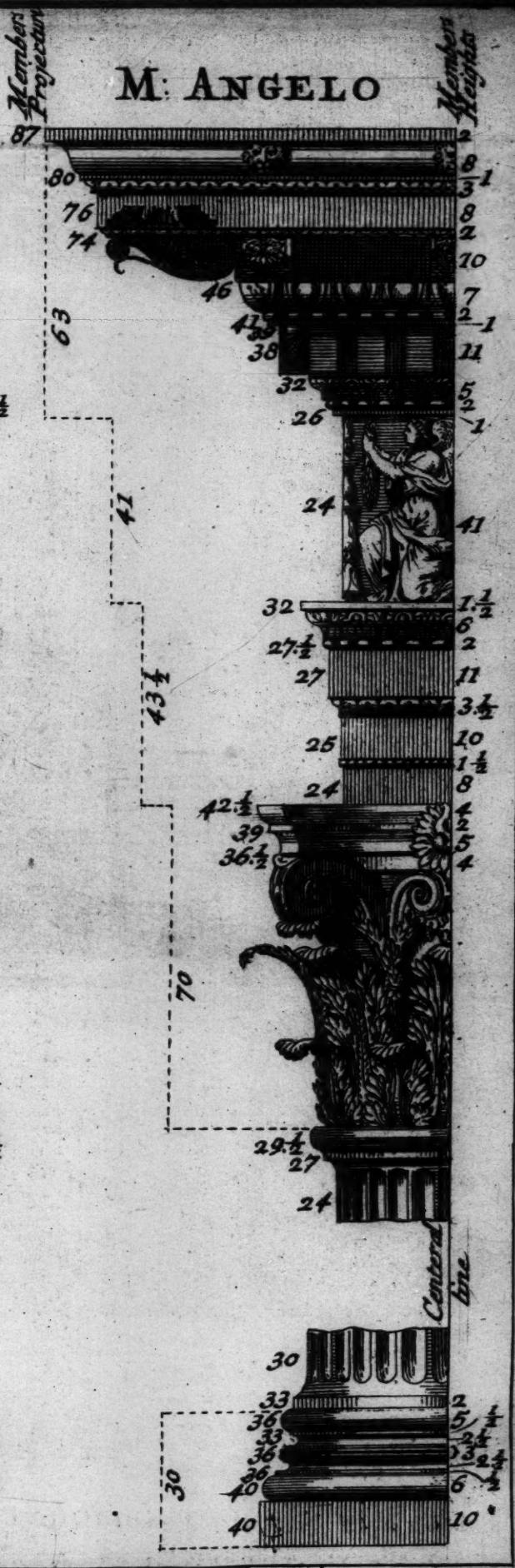
VITRUVIUS.



PERRAULT



M: ANGELO



Geometrical Elevations of the *COMPOSITA* Base, Capitals and Entablatures according to the Proportions of

Plate XXIX

SERLIO.

SCAMOZZI.

PALLADIO.

The ARCH of TITUS at *ROME*.

The ARCO de LEONI at *VERONA*.

Members Projecture

Members Heights

Centeral line

An Oblique view of the Acanthus leaf.

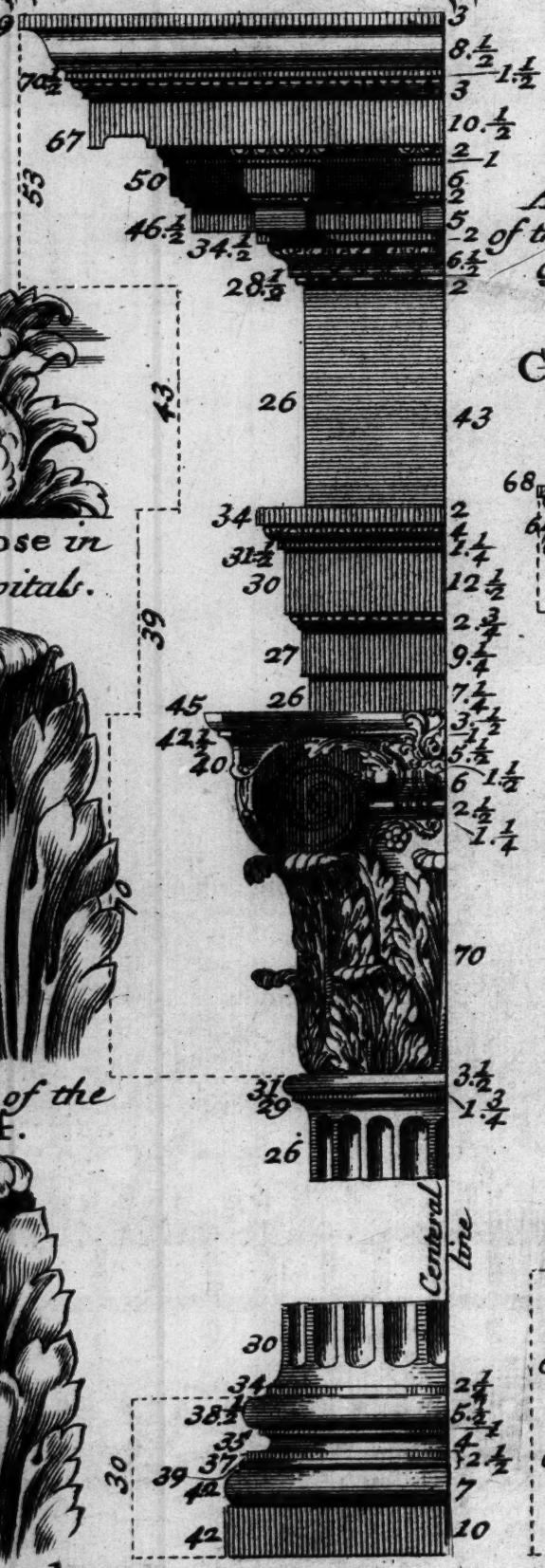
A Direct view of the Rose *in the* Abacus *of y^e Capitals.*

Cauticole *terminating in a* Rose.

A Direct view of the Laurel leaf.

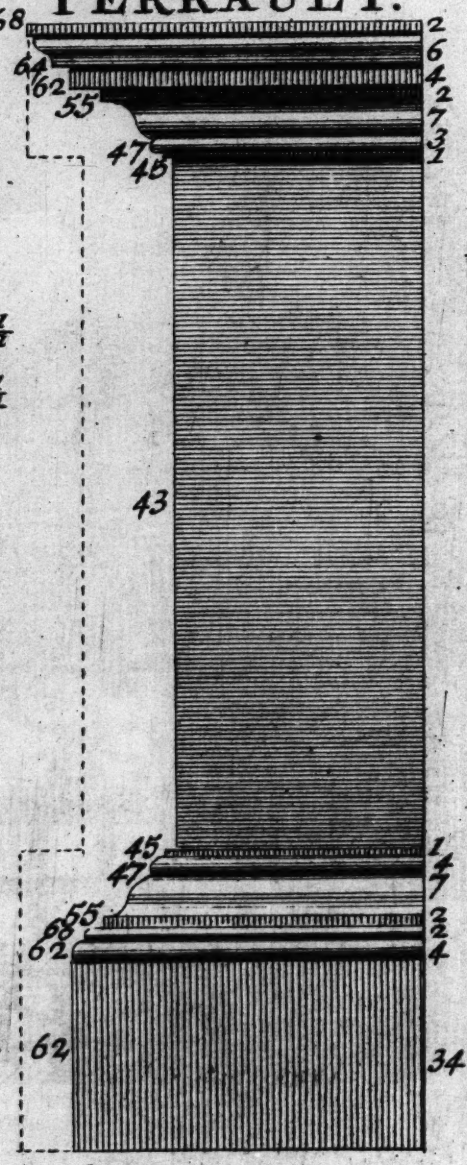
The Acanthus leaves.

LE CLERC'S Roman Order.

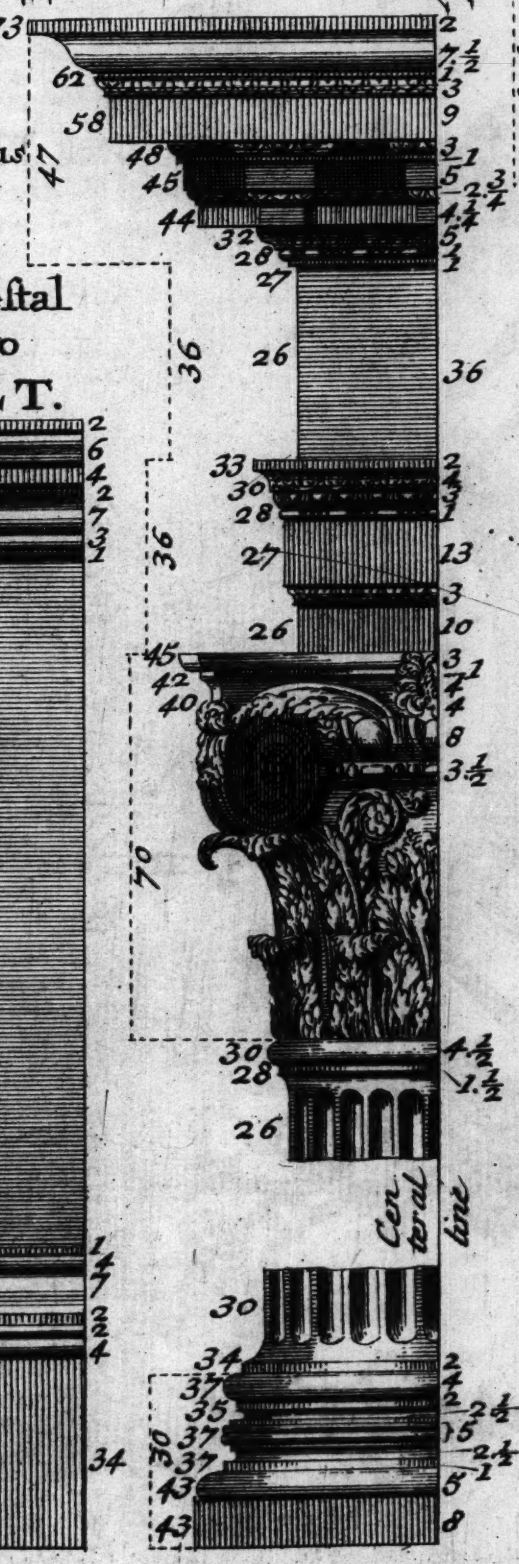


An Oblique view of the Rose *in y^e* Abacus *of the Capitals.*

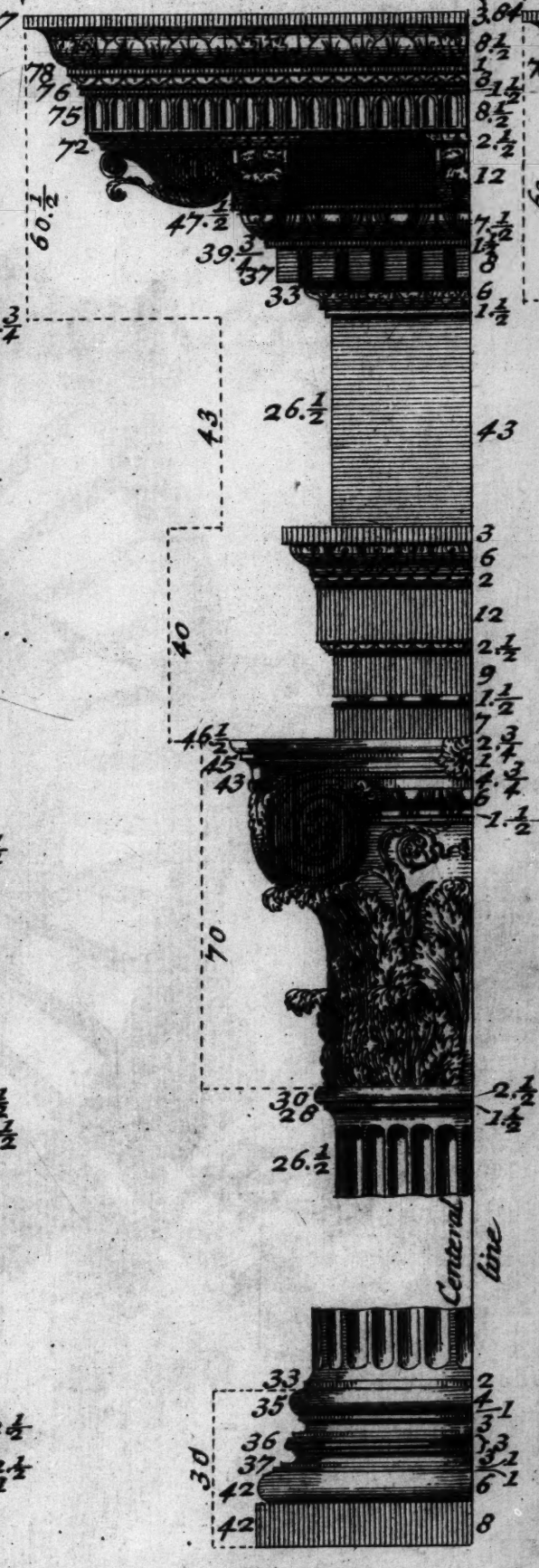
Composite Pedestal according to PERRAULT.



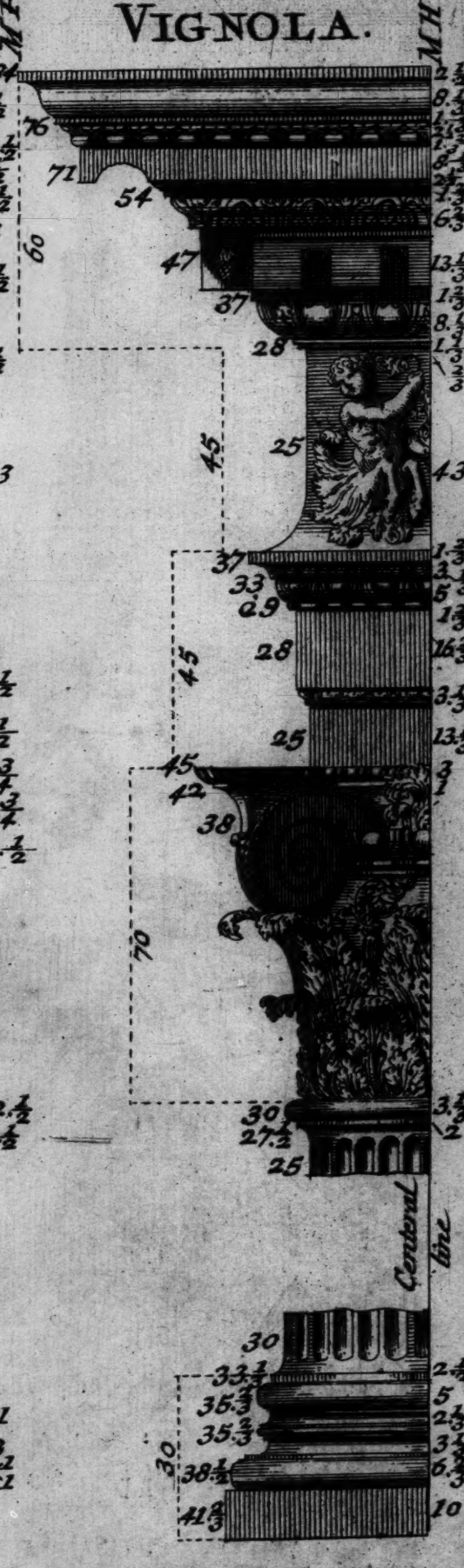
PERRAULT.



BOSSE.

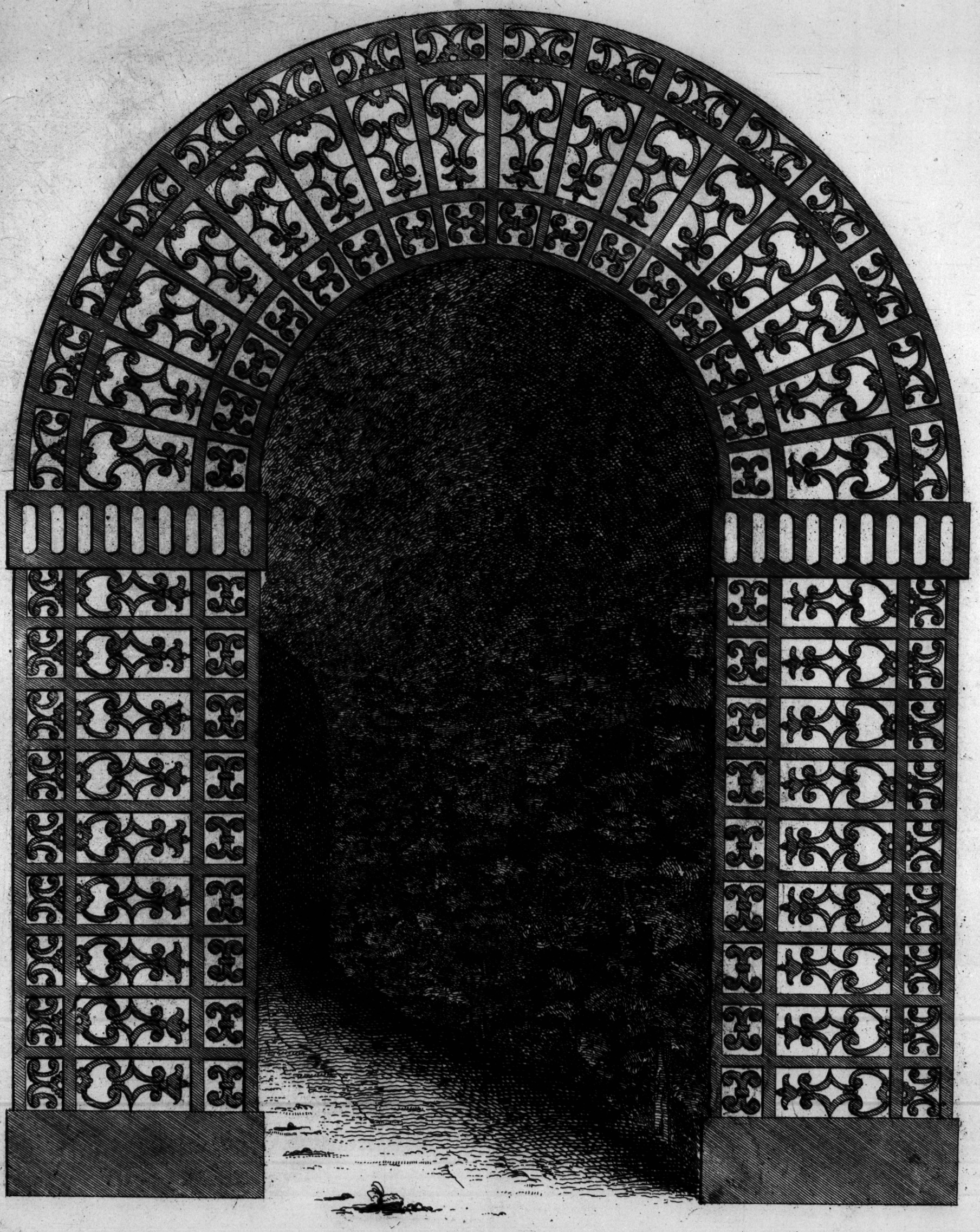


VIGNOLA.



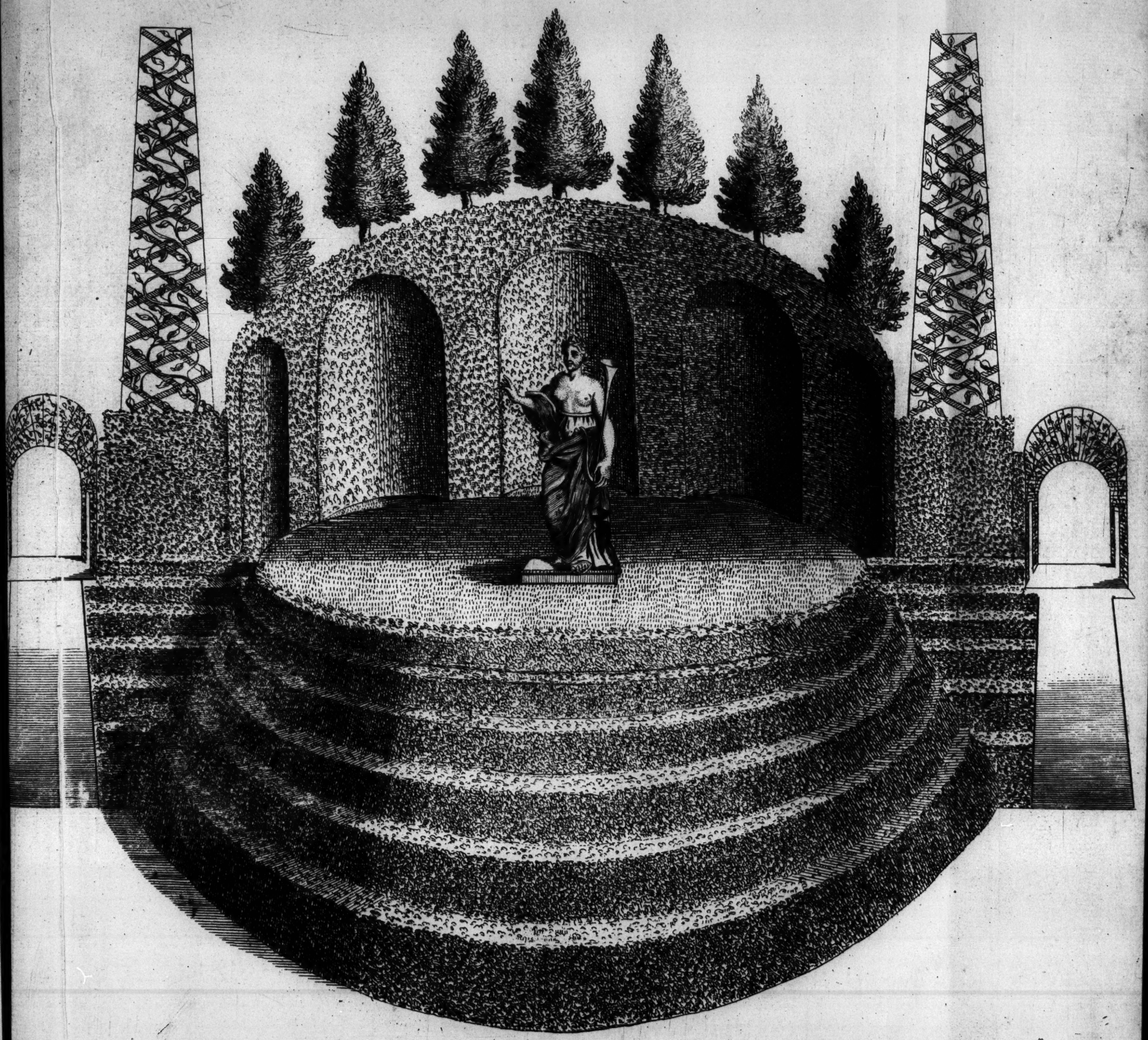
The Frontispiece to an entrance side in Stucco or Estructure Work

Plate XXXI.



The Frontispiece of an Enterance into a Shady or Artinatural Walk

Plate XXXII



An Amphitheatrical mount of ever Green's
for y^e^ Termination of a grand Walk.

Geometrical Elevations for Entrances into Grotto's and Caves.

Composite Capital with leaves of ye Star Thistle by I. Bosse

Plate X

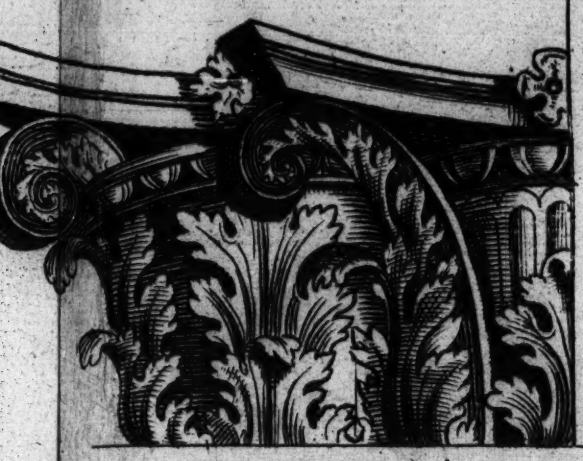
attick Base by

from Vitruvius

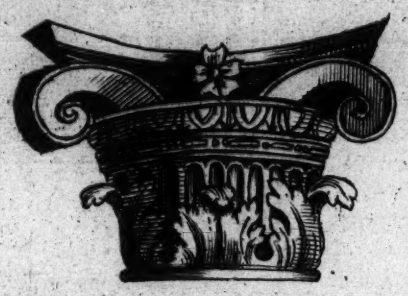
The Geomatrical upright of an noble Structure, Design'd according to ye Grand manner o

e XXIV

e by Vitruvius



from Vitruvius



from Vitruvius

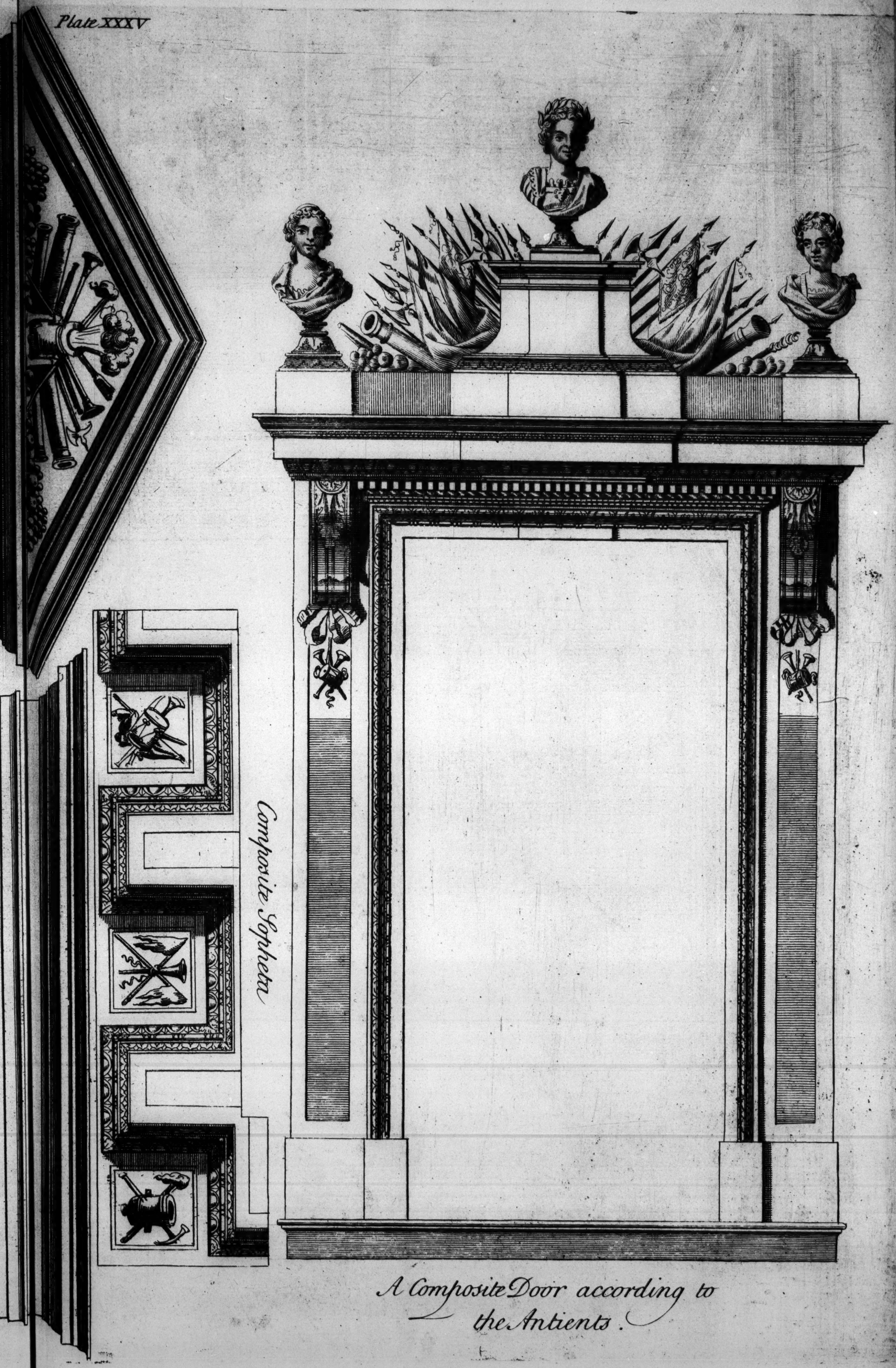
Corinthian Capital with olive leaves by A. Bosse

Corinthian Capital with acanthus leaves by Vitruvius

of Palladio

an Enrichment for the Freize of ye Ionick Order

Geometrical Enterances according to the Tuscan Order of the Antients.



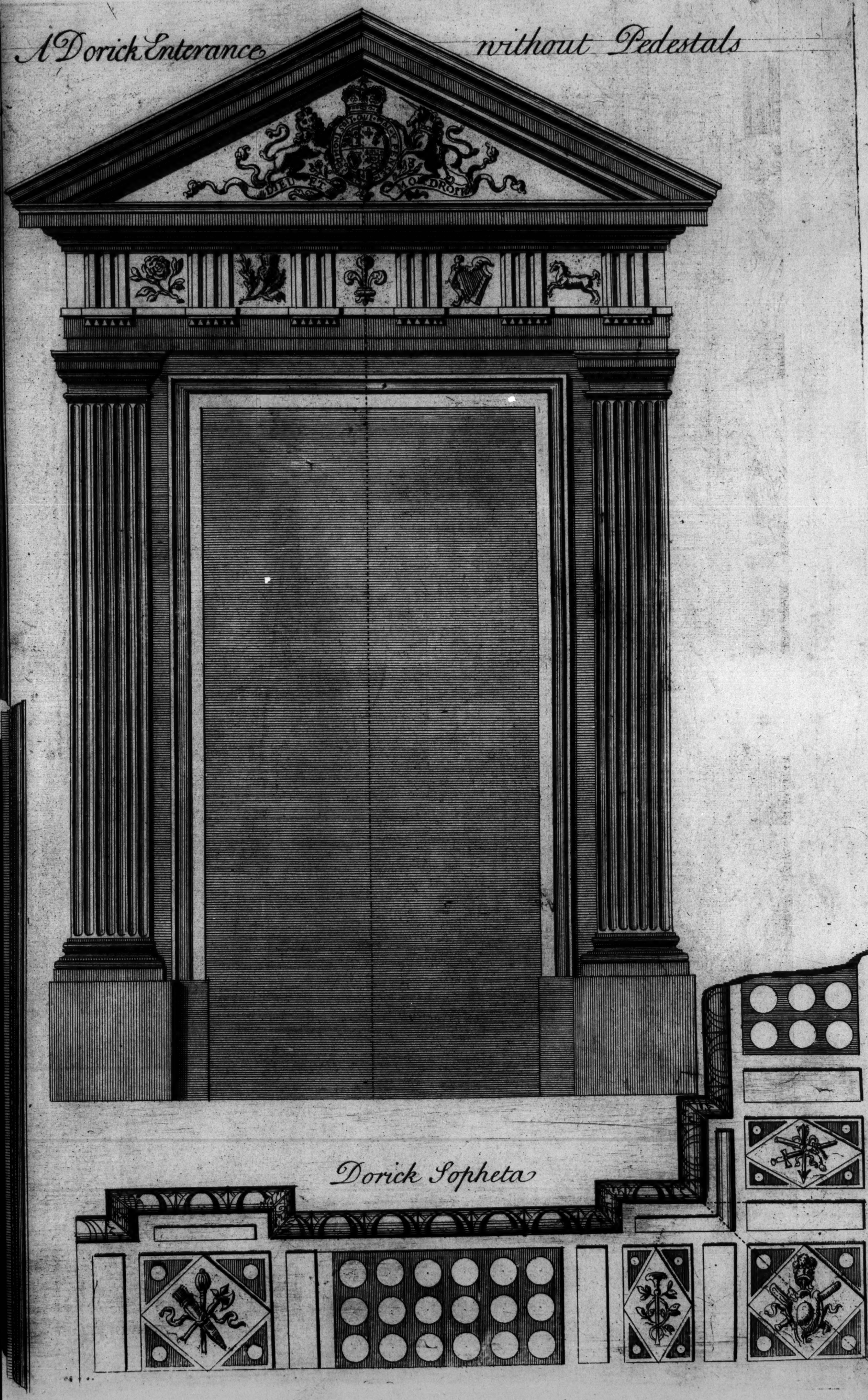
Composite Sopheta

A Composite Door according to the Antients.

A Dorick Enterance
with Pedestals.

Dorick Neath

A Dorick Enterance without Pedestals



Dorick Sopheta

Tonick Neath

Plate XXXVII

A Ionick

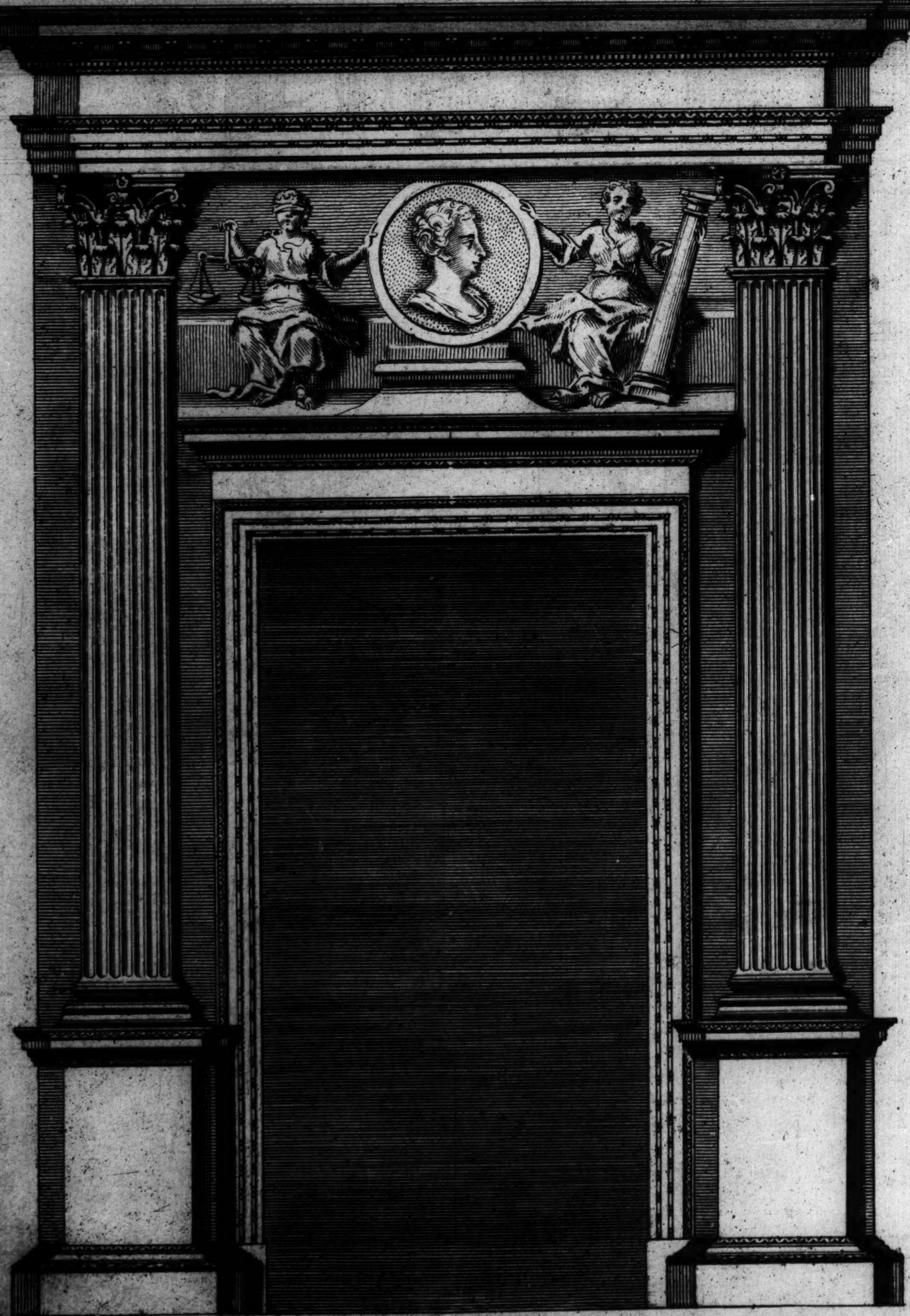
Door without Pedestals

A Ionick

Door with Pedestals

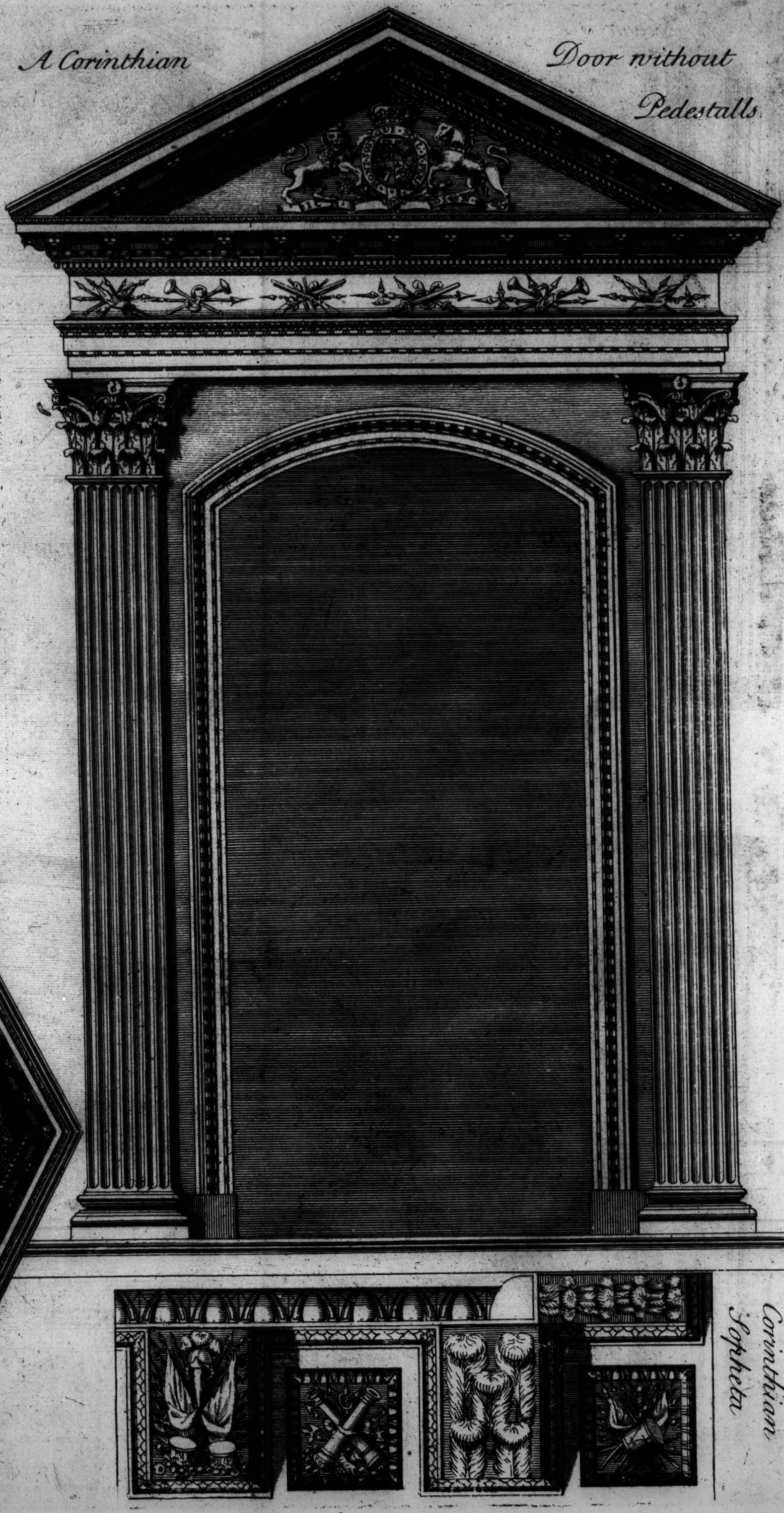
Ionick Sopheta

Plate XXX



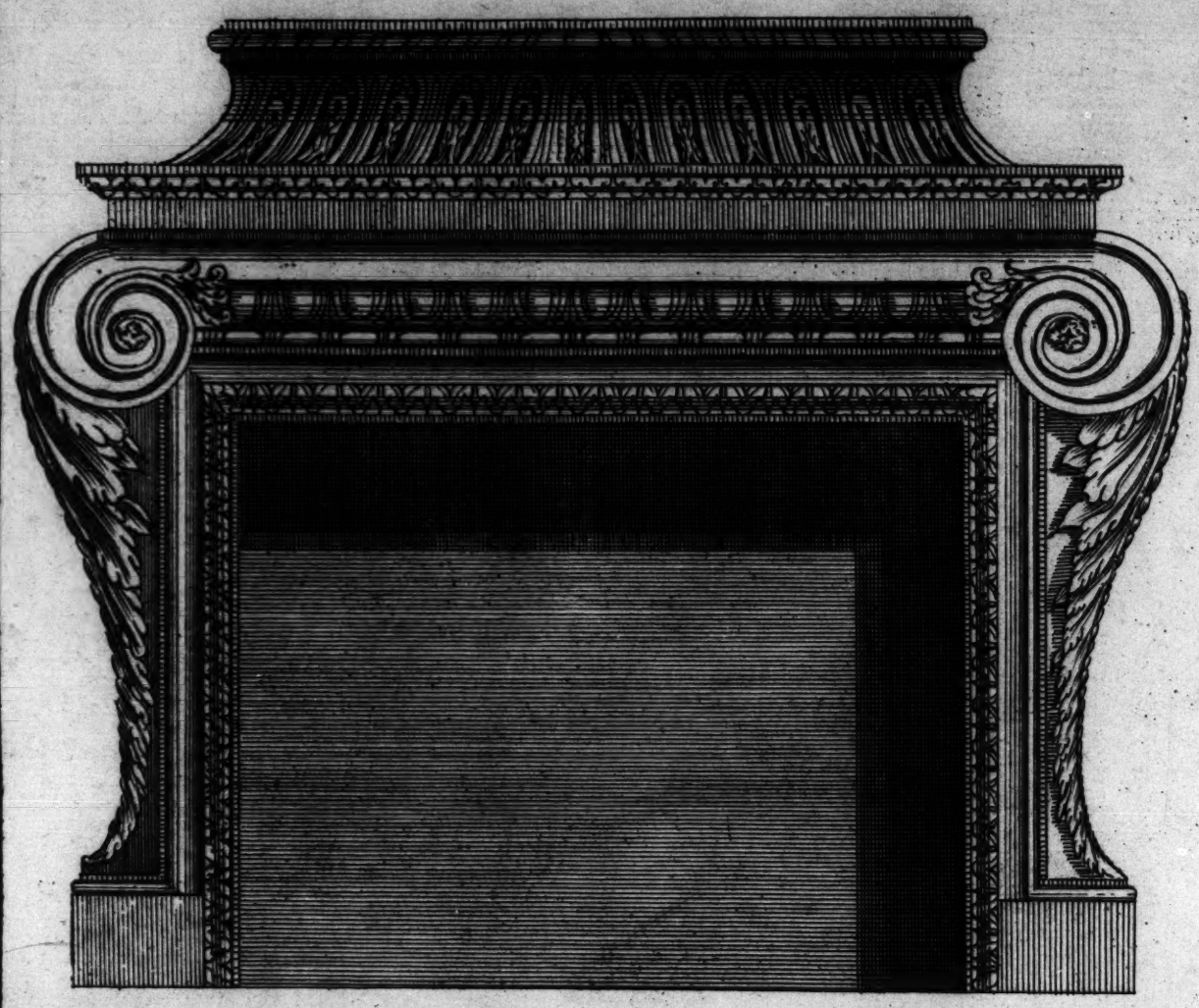
Corinthian Neath

A Corinthian Door without Pedestalls.

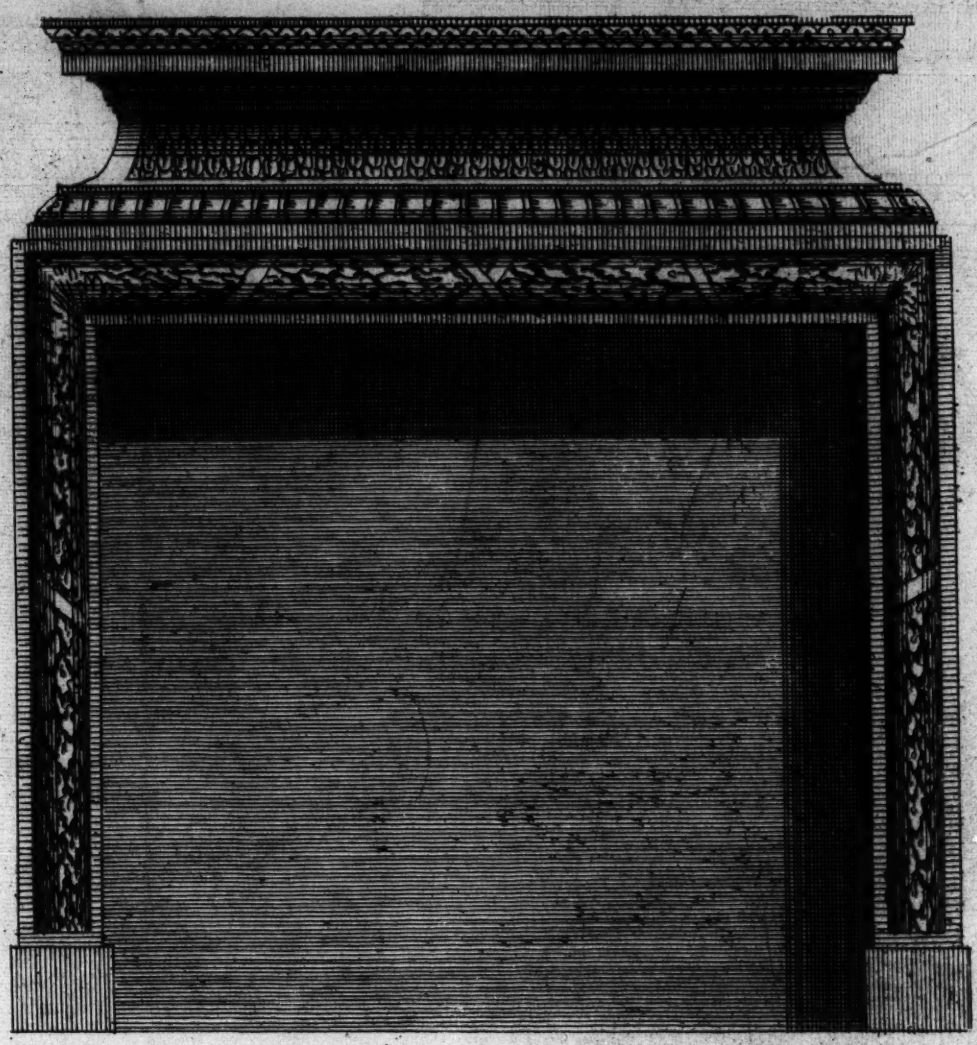


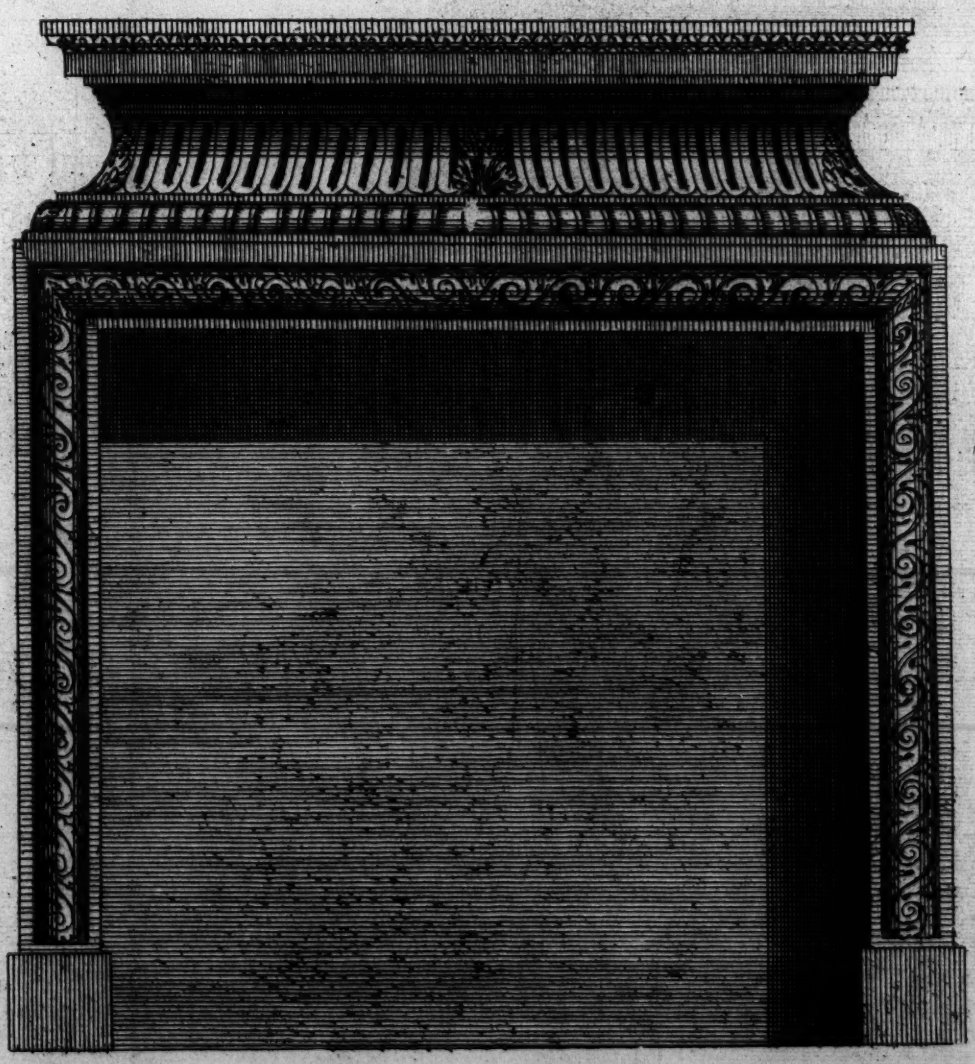
Corinthian Sophieta

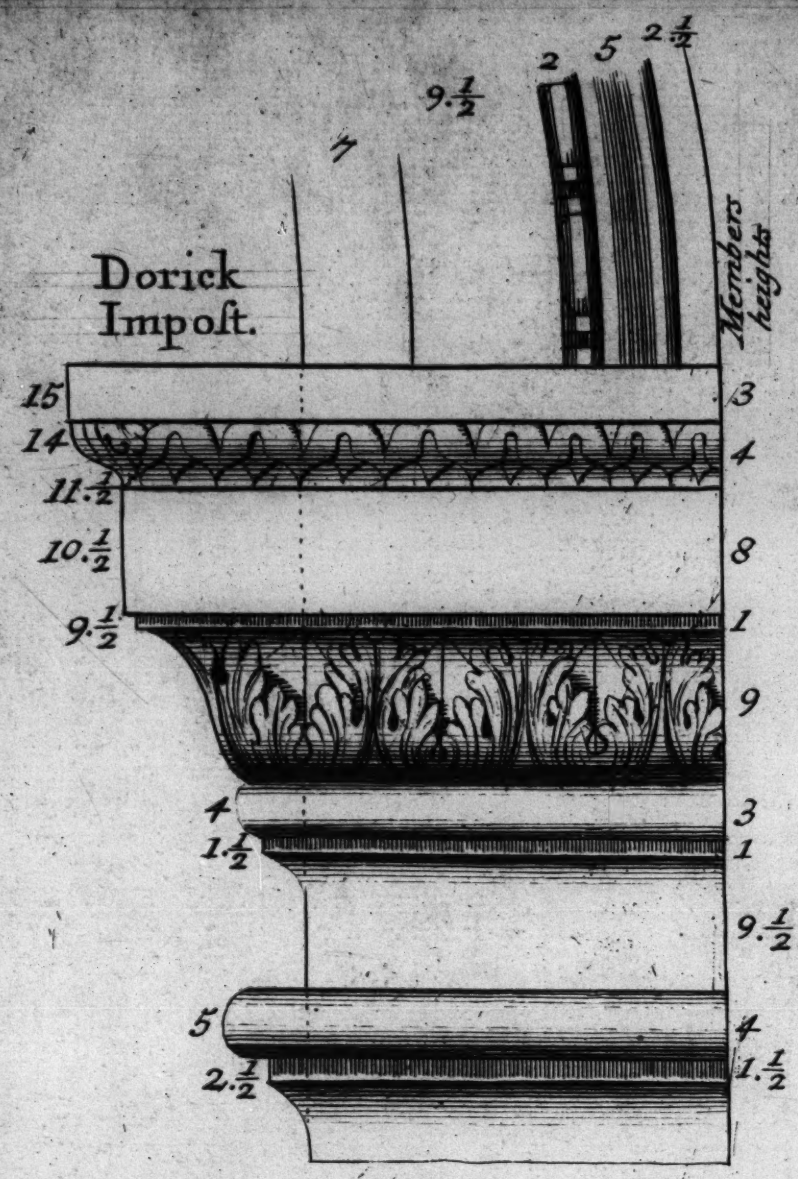
an Enrichment for the Ionick Freize

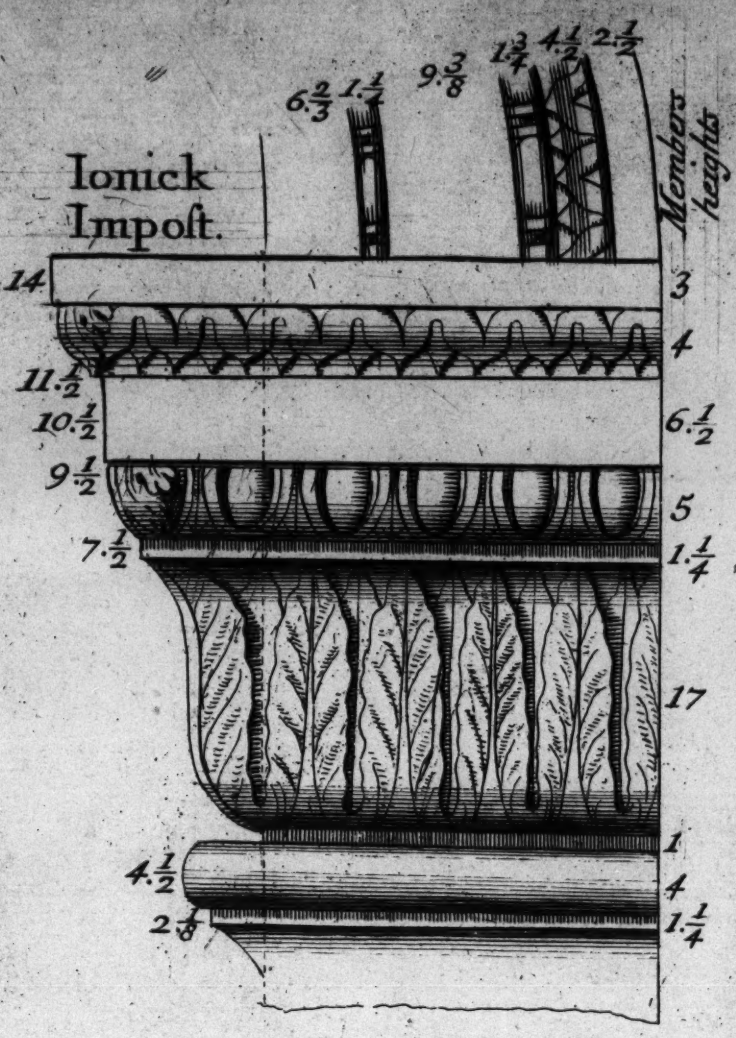


An Enrichment for ye Corinthian Frieze

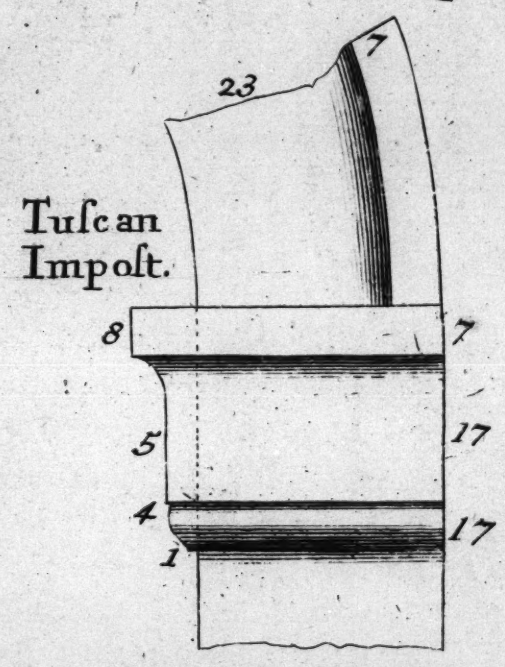


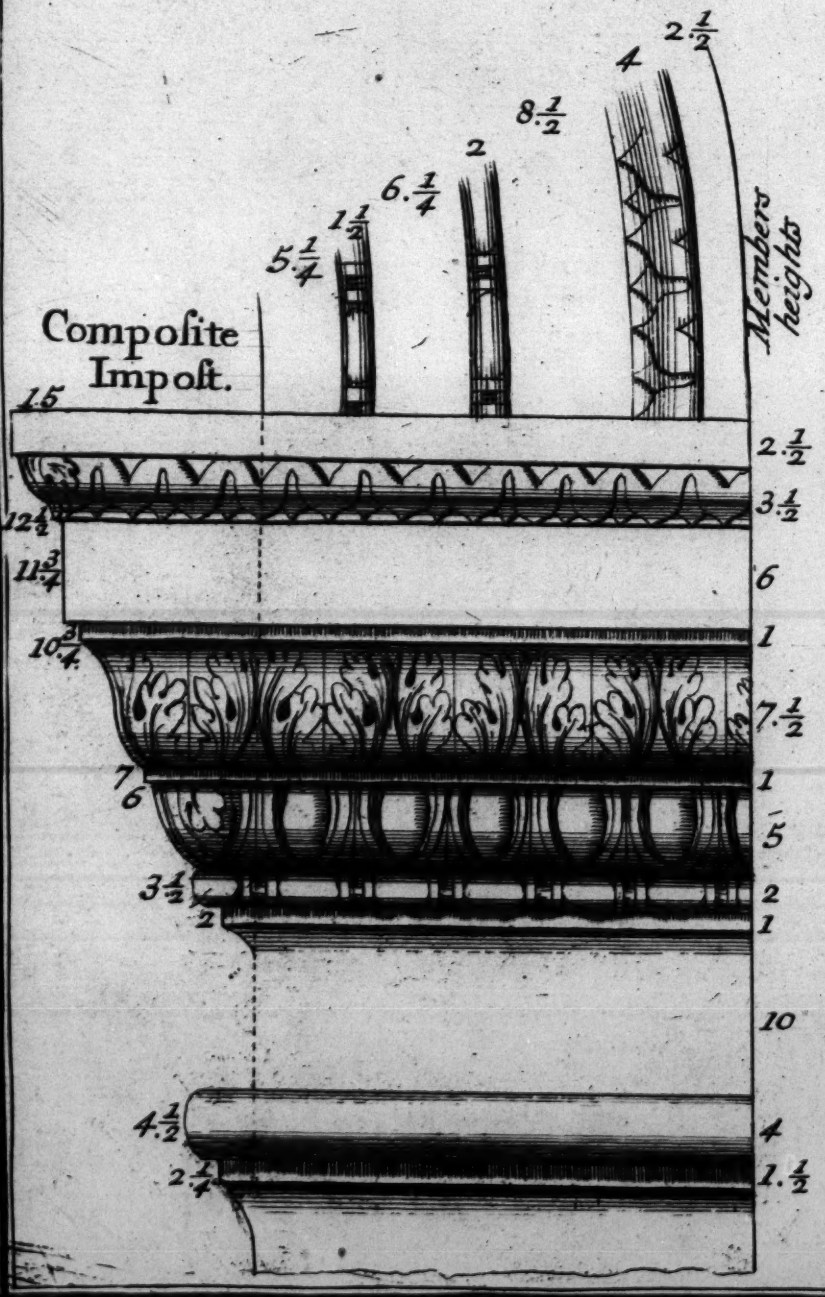


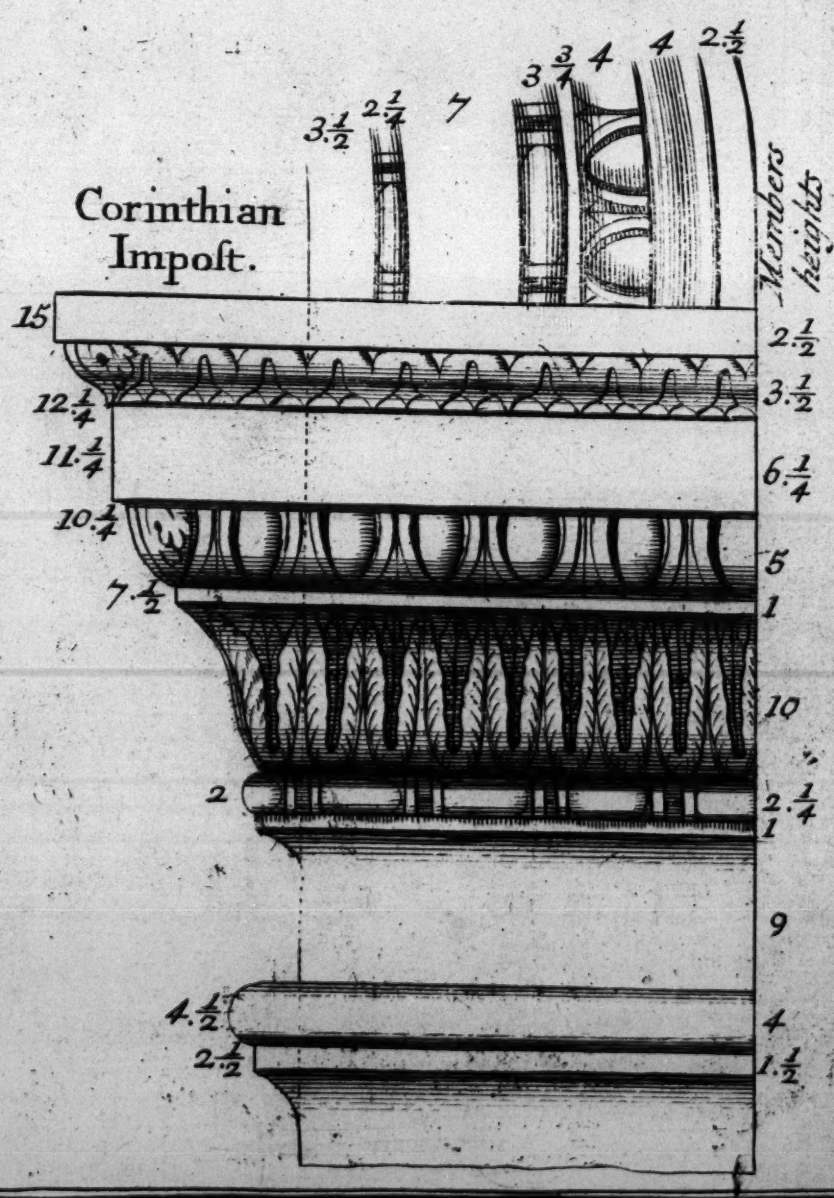




Impoſts and Ornaments of the *TUSCAN. DORICK. IONICK. CORINTHIAN* and *COMPOSITE* Orders of Architecture.







Doorway from the Antients

Ionick Colonade taken from Mary Aegipton